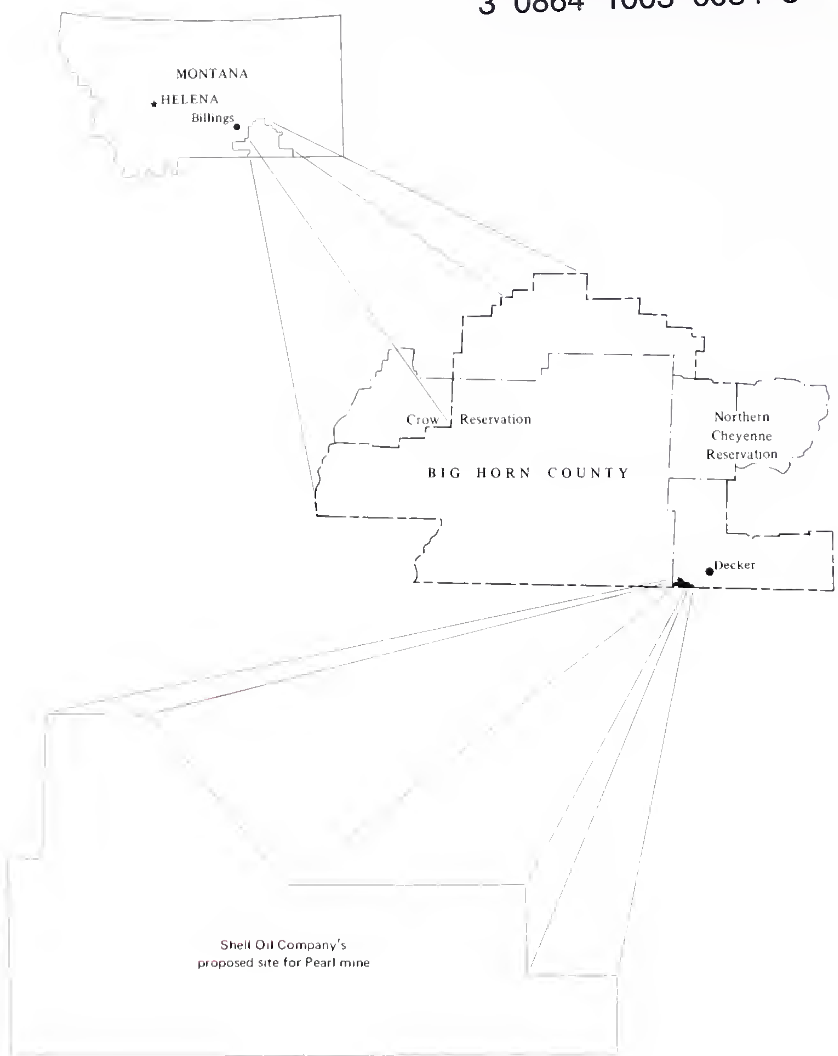
PROPOSED MINING AND RECLAMATION PLAN,

Pearl Mine,

BIG HORN COUNTY, MONTANA

DRAFT ENVIRONMENTAL STATEMENT



ENGLISH-METRIC CONVERSION FACTORS

To convert English unit	Multiply by	To obtain Metric unit
Inches (in)--------------	2.54	Centimeters (cm).
Feet (ft)----------------	3.048×10^{1}	Centimeters (cm).
	3.048×10^{-1}	Meters (m).
Miles (mi)---------------	1.609	Kilometers (km).
Square feet (ft^2)--------	9.290×10^{-2}	Square meters (m^2).
Acres--------------------	4.047×10^{-1}	Hectares (ha).
	4.047×10^{-3}	Square kilometers (km^2).
Acre-feet (acre-ft)------	1.233×10^{3}	Cubic meters (m^3).
	1.233×10^{-3}	Cubic hectometers (hm^3).
Cubic yards (yd^3)--------	7.646×10^{-1}	Cubic meters (m^3).
Pounds (lb)--------------	4.536×10^{-1}	Kilograms (kg).
Short tons (tons)--------	9.072×10^{-1}	Metric tons (t).
Pounds per acre (lb/acre)	1.12	Kilograms per hectare (kg/ha).
Btu/lb-------------------	2.326	Kilojoules per kilogram (kJ/kg).
Gallons (gal)------------	3.785×10^{-3}	Cubic meters (m^3).
Gallons per minute (gal/min)--------------	6.309×10^{-2}	Liters per second (L/s).
Degrees Fahrenheit (°F)--	([1])	Degrees Celsius (°C).

[1]Temperature in °C =(temperature in °F − 32)/1.8.

[redacted]

U.S. DEPARTMENT OF THE INTERIOR
MONTANA DEPARTMENT OF STATE LANDS

DRAFT
ENVIRONMENTAL STATEMENT

PROPOSED MINING AND RECLAMATION PLAN, PEARL MINE, BIG HORN COUNTY, MONTANA

Prepared by
Geological Survey, Department of the Interior
Montana Department of State Lands

Leo Berry, Jr., Commissioner
Montana Department of State Lands

H. William Menard, Director
U.S. Geological Survey

1979

SUMMARY

PEARL MINE PROPOSAL

(X) Draft ( ) Final Environment Statement

Department of the Interior, U. S. Geological Survey

Montana Department of State Lands

1. Type of action: (X) Administrative ( ) Legislative

2. Brief description of the action:

State and Federal actions involve decisions regarding the permit applications for the mining and reclamation plans for the Pearl mine, Shell Oil Company, Big Horn County, Montana. The company proposes to open a new coal mine, including roads and facilities, as well as extend a rail spur from the Decker spur to the Pearl minesite. An estimated 46.5 million tons of low-sulfur coal would be removed from an area of about 616 acres over a period of 27 years.

3. Summary of adverse, unavoidable environmental impacts:

A. Existing soils, vegetation, and wildlife habitat would be disturbed or destroyed incrementally on 1,462 acres over a 27-year period, and their diversity would be lost for possibly several decades or longer following reclamation.

b. Existing local shallow aquifers would be destroyed and replaced with spoils, which when resaturated, would contain water of poor quality, which would probably be unsuitable for domestic or livestock use. If the restoration of the alluvial aquifer were not successful, springs along Little Youngs Creek could become dry, and the reclamation of the riparian vegetation could be adversely affected. This in turn would preclude the reestablishment of premining wildlife populations dependent on this type of habitat.

D. During mining, fugitive dust emissions would increase twofold to eightfold. Emissions would sporadically exceed State and Federal air quality standards. Gaseous emissions would increase but would probably not violate standards. Visibility would be decreased locally during mining.

E. Population in Sheridan County, Wyoming, (assuming no new town) would increase by approximately 460 persons (including mine employees, ancillary employees, and their families) by 1990 due to the Pearl mine. As a result, traffic would

increase. Approximately 49 acres of land would be taken out of production for subdivision development. Community services would be further stressed.

G. Sixteen cultural resource sites would be disturbed or destroyed in the 1,462-acre permit area. One of these is eligible for nomination to the National Register of Historic places, another may be eligible (a determination is now being made).

H. Train traffic on the Decker spur and beyond would increase by about 400 unit trains per year including empties, increasing noise, dust, and gaseous air pollution along the right-of-way and increasing the probability of traffic hazards at road crossings.

4. Alternatives considered:

Alternatives available to State and Federal agencies include: (a) no action, approval as proposed; (b) deferring action; (c) preventing further development by suspending operations, cancelling the lease, or acquiring the lease; and (d) rejecting the mine and reclamation plan or restricting development on the lease. Other options include development of selected areas now under lease and approval of the proposed mining plan after modification. The mining and reclamation plan must be modified to meet criteria set forth in the Surface Mining Control and Reclamation Act of 1977, and the Montana Strip and Underground Mine Reclamation Act of 1973 and other pertinent criteria. Agencies may also add stipulations to permit approval which would minimize the environmental impacts by imposing various technical alternatives. The major stipulations to be considered include: The use of best available control technology for all mine dust and gaseous emissions; implementaion of a monitoring system for ambient air; double-lift salvage of topsoil; selective salvage and replacement of soils to better simulate premining conditions; and reduction of slope lengths to minimize erosion.

SUMMARY ATTACHMENT I

Comments are being requested from the following:

Federal agencies:

Advisory Council on Historic Preservation
Department of Agriculture
  Forest Service
  Soil Conservation Service
Department of the Army
  Corps of Engineers
Department of Commerce
  Old West Regional Commission
Department of Energy
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of Interior
  Bureau of Indian Affairs
  Bureau of Mines
  Bureau of Reclamation
  Fish and Wildlife Service
  Heritage Conservation and Recreation Service
  National Park Service
  Office of Surface Mining
Department of Labor
  Mining Safety and Health Administration
Department of Transportation
Environmental Protection Agency
Federal Energy Regulatory Commission
Interstate Commerce Commission

State and local agencies:

Office of the Governor, Montana
Office of the Governor, Wyoming
Montana Agricultural Experiment Station
Montana Bureau of Mines and Geology
Montana Department of Community Affairs
Montana Department of Fish and Game
Montana Department of Health and Environmental Sciences
Montana Department of Natural Resources and Conservation
Montana Department of Revenue
Montana Energy Advisory Council
Montana Environmental Quality Council
Montana State Historic Preservation Office
Board of County Commissioners, Big Horn County, Montana
Board of County Commissioners, Rosebud County, Montana
Board of County Commissioners, Sheridan County, Wyoming
Mayor, City of Sheridan

Tribal councils:

Northern Cheyenne
Crow

Applicant:

Shell Oil Company

CONTENTS

ILLUSTRATIONS

TABLES

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

A. INTRODUCTION

This statement analyzes the environmental impacts of a new surface coal mine in southern Big Horn County proposed by Shell Oil Company (Shell) (fig. I-1,I-2). This EIS is a joint Federal-State effort based on the company's permit applications.

Shell's proposed Pearl mine would produce an average of 2 million tons of subbituminous coal per year from Federal Lease M-069945 (Montana), over a 24 year period. Reclamation would continue through year 27. Mining by conventional truck and shovel methods would recover coal primarily from three of the area's seven coal seams, mining to a maximum depth of approximately 400 feet. The mine plan proposes to construct ancillary facilities and a railroad spur, and to relocate a county road. The total permit area would be 1,462 acres, of which about 541 acres are contained in the Federal coal lease. Approximately 1,196 acres would be disturbed by the facilities, mining, and associated activities. Because the mine would draw about 460 people to the area, it would increase the need for expansion of services and facilities.

At present Shell has no contracts for the coal from the Pearl mine. The coal, to be mined for electrical generation, is, in general, low-sulfur and of relatively high quality suitable for steam generation and/or industrial use.

On June 16, 1977, Shell submitted a proposed mining and reclamation plan to the Department of Interior in accordance with 30 CFR 211 Coal Mining Operation Regulations. Shell's permit application to the State of Montana was received on January 20, 1978 in accordance with the Montana Strip and Underground Mine Reclamation Act. On April 11, 1979 Shell submitted a revised application in accordance with the Surface Mine Control and Reclamation Act. These applications and supporting material are on file and can be viewed by the public at the following locations: Office of the Area Mining Supervisor, Conservation Division, U.S. Geological Survey, 3 Seventh Ave. West, Billings, Montana; and the Department of State Lands, 1625 11th Avenue, Helena, Montana.

B. FEDERAL, STATE, AND COUNTY ACTIONS

Federal, State, and county authorities must approve or deny applications for permits necessary for the proposed mining (table I-1). Stipulations may also be imposed. (See regional volume, chapter III.)

<u>The mining and reclamation plan discussed in this statement was submitted for review prior to the promulgation of initial regulations (30 CFR 700) required under sections 502 and 523 of the Surface</u>

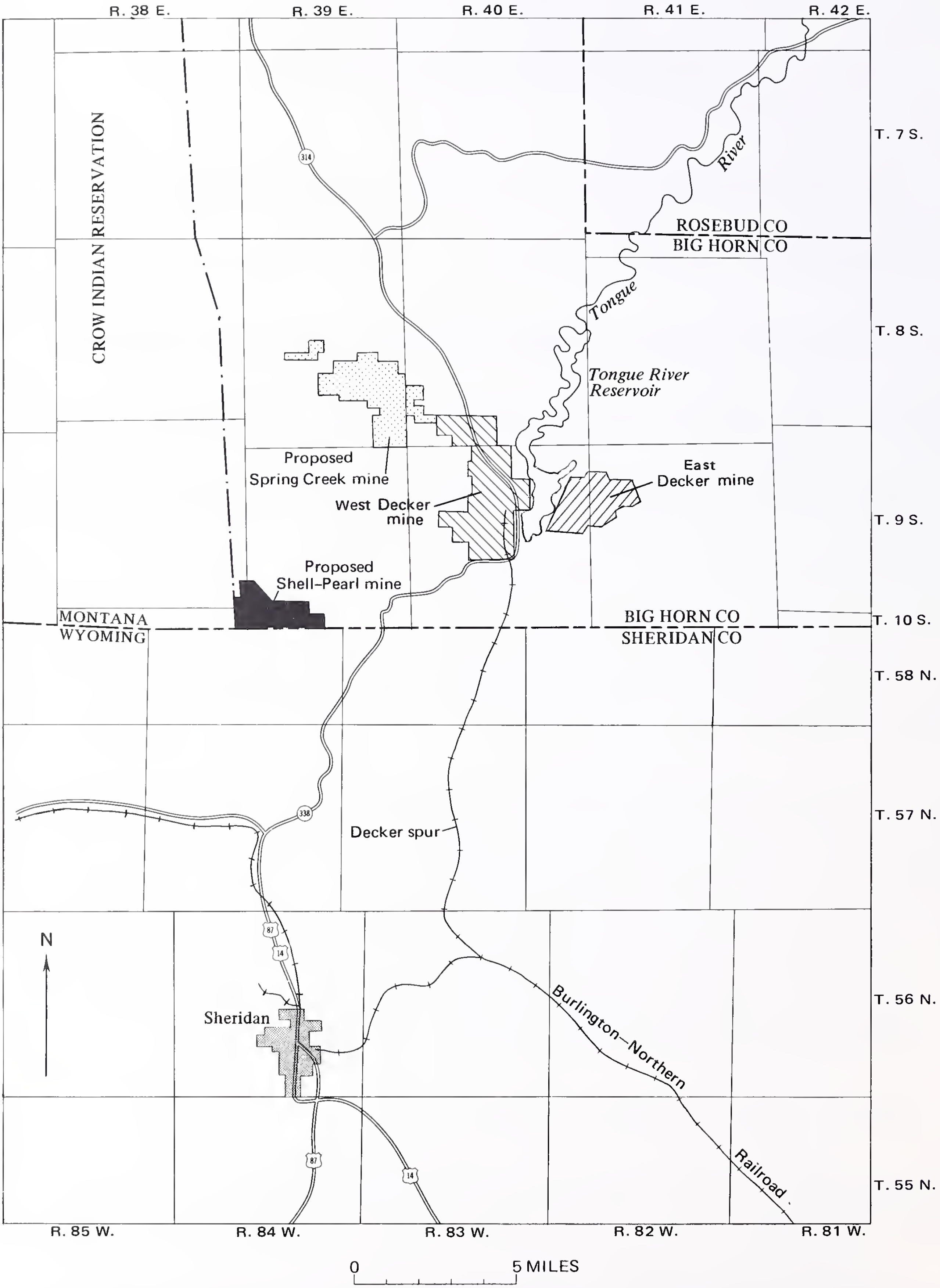


Figure I-1.—Location map.

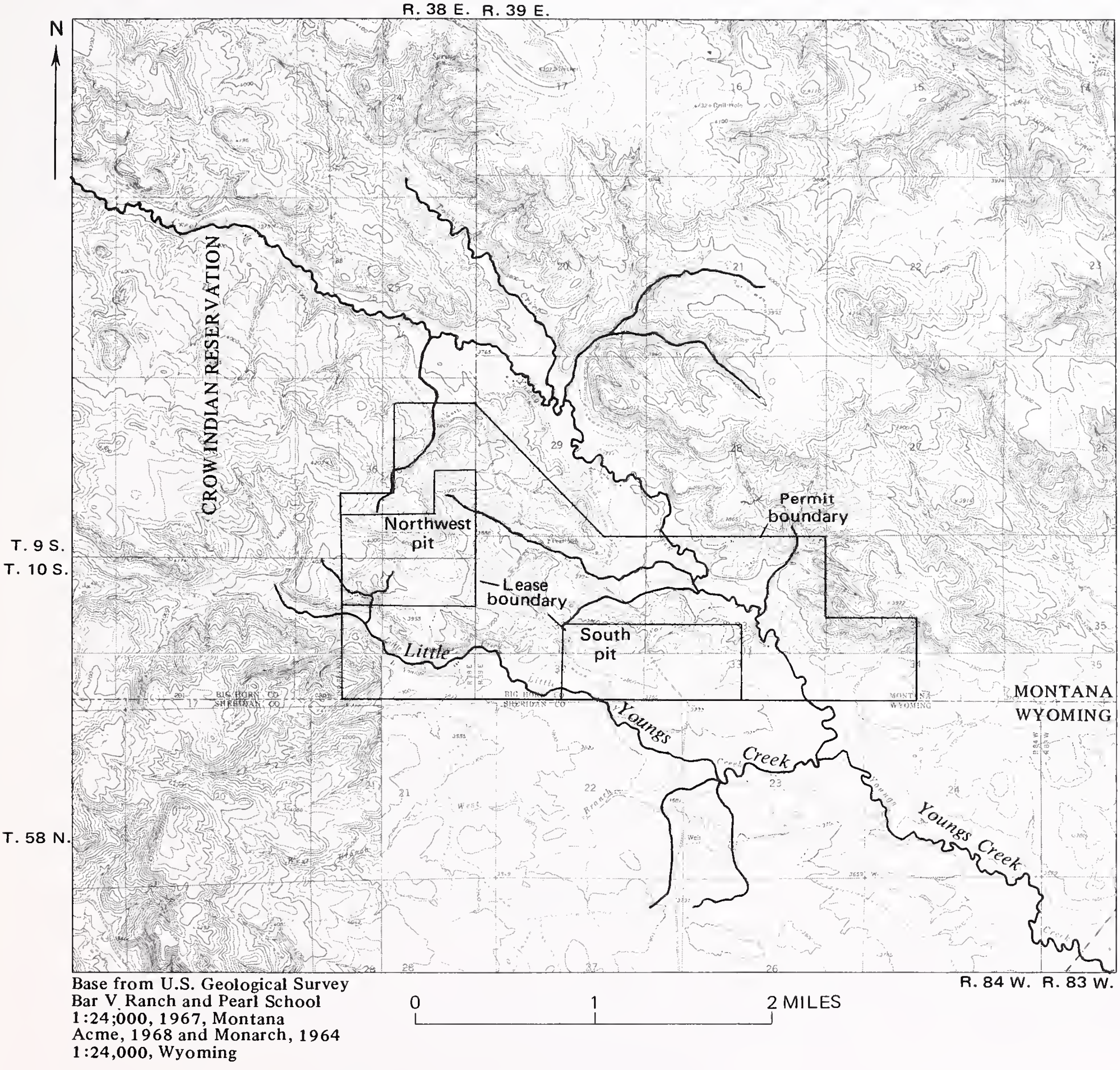


Figure I-2.—Topography.

and the emergency regulations promulgated under the Montana Strip and Underground Mine Reclamation Act of 1973 (Part 2, Chapter 4, Title 82, MCA). The company's June 1977 mining and reclamation plan was reviewed for compliance and did not reflect the initial requirements of these regulations (appendix A). The April 11, 1979 application was revised to comply with the interim regulations, but it has not yet been reviewed. Final regulations went into effect April 12, 1979 and are not addressed in the revised application. However, any mining must be in full compliance with the final regulations; this has been considered to the extent possible in the analysis.

The Office of Surface Mining and the Montana Department of State Lands will be reevaluating the revised plan for compliance with Federal and State regulations.

TABLE I-1.--Permits required for the Pearl mine

Permit	Authorizing agency
Surface mining and reclamation	Office of Surface Mining; U.S. Geological Survey; Montana Department of State Lands, Bureau of Land Management; Wyoming Department of Environmental Quality
Rights-of-way for railroad, powerline, and access road	Montana Department of Highways; Big Horn County, Montana; Wyoming Department of Environmental Quality; Bureau of Land Management
Streambed construction and runoff retention	Army Corps of Engineers; Montana Department of Health and Environmental Sciences; Montana Department of Natural Resources and Conservation; Big Horn Conservation District
Sewage, solid waste, and temporary oil waste disposal	Montana Department of Health and Environmental Sciences; Big Horn County, Montana
Explosive manufacturing and storage	U.S. Treasury
Water supplies	Montana Department of Health and Environmental Sciences; Montana Department of Natural Resources and Conservation
Building construction and housing	Montana Department of Administration; Montana Department of Community Affairs; Montana Department of Health and Environmental Sciences; Big Horn County, Montana
Air quality emissions	Environmental Protection Agency; Montana Department of Health and Environmental Sciences
High structures (radio tower and coal storage building)	Federal Aviation Administration
Radio transmission	Federal Communication Commission

C. BACKGROUND AND LEASE HISTORY

The proposed mine is on Federal coal lease M-069945, held by Shell Oil Company. The lease covers approximately 541 acres in Big Horn County, Montana (fig. I-3).

Surface ownership in the lease area is shown in figure I-4; mineral ownership is shown in figure I-5; and oil and gas leases are shown in figure I-6. Not all the lands which would be affected are owned by Shell, but Shell does not anticipate significant difficulties in reaching a satisfactory agreement allowing construction or erection of facilities. The right to use land surface owned by the Federal Government would be obtained either by purchase, by exchange of nearby Shell-owned acreage, or by a Temporary Use Permit (TUP) from the Bureau of Land Management.

The lease originated as an application for a coal prospecting permit by Dr. J. C. Karcher in November 1964, but because of a showing of coal in commercial quantities this permit application was rejected. The lands were then offered for lease in a competitive-bid sale, which was held on May 26, 1965. The lease, originally 692.66 acres, was obtained by Dr. Karcher and was issued on July 1, 1965. A modification of the lease on January 28, 1966 added another 158.90 acres, but was followed by a partial relinquishment of 310.7 acres on June 20, 1966. The present lease contains 540.86 acres underlain by an estimated 60 million tons of coal.

During 1967 the lease was transferred to Concho Petroleum Co.; then to Humic Acid Products of America, Inc.; and finally back to Concho Petroleum Co. It was then purchased by Shell Oil Company in August 1975, with approval of the Bureau of Land Management in September 1975. In May 1976, Shell was granted permission from the Bureau of Land Management to do exploratory drilling on the lease.

The lease provides for a royalty of 17.5 cents/ton for coal mined during the first 10 years of the lease and 20 cents/ton for coal mined during the remainder of the first 20-year period. Annual rental is set at 25 cents/acre for the first year, 50 cents/acre for the second through fifth years, and $1/acre for the sixth and each succeeding year. This rental for any given year is to be credited against the first royalties accrued during that year for which the rental is paid. Lease terms are subject to reasonable readjustment at the end of every 20-year period.

D. SITE LOCATION AND DESCRIPTION

The lease area consists of two tracts approximately one-half mile apart. The south tract (264 acres) lies on the Montana-Wyoming border in parts of secs. 32 and 33, T. 9 S., R. 39 E., while the northwest tract (277 acres) adjoins the Crow Indian Reservation in parts of sec. 36, T. 9 S., R. 38 E., and sec. 1, T. 1 S., R. 38 E. Both tracts are between Little Youngs and Youngs Creeks (fig. I-3). Little Youngs

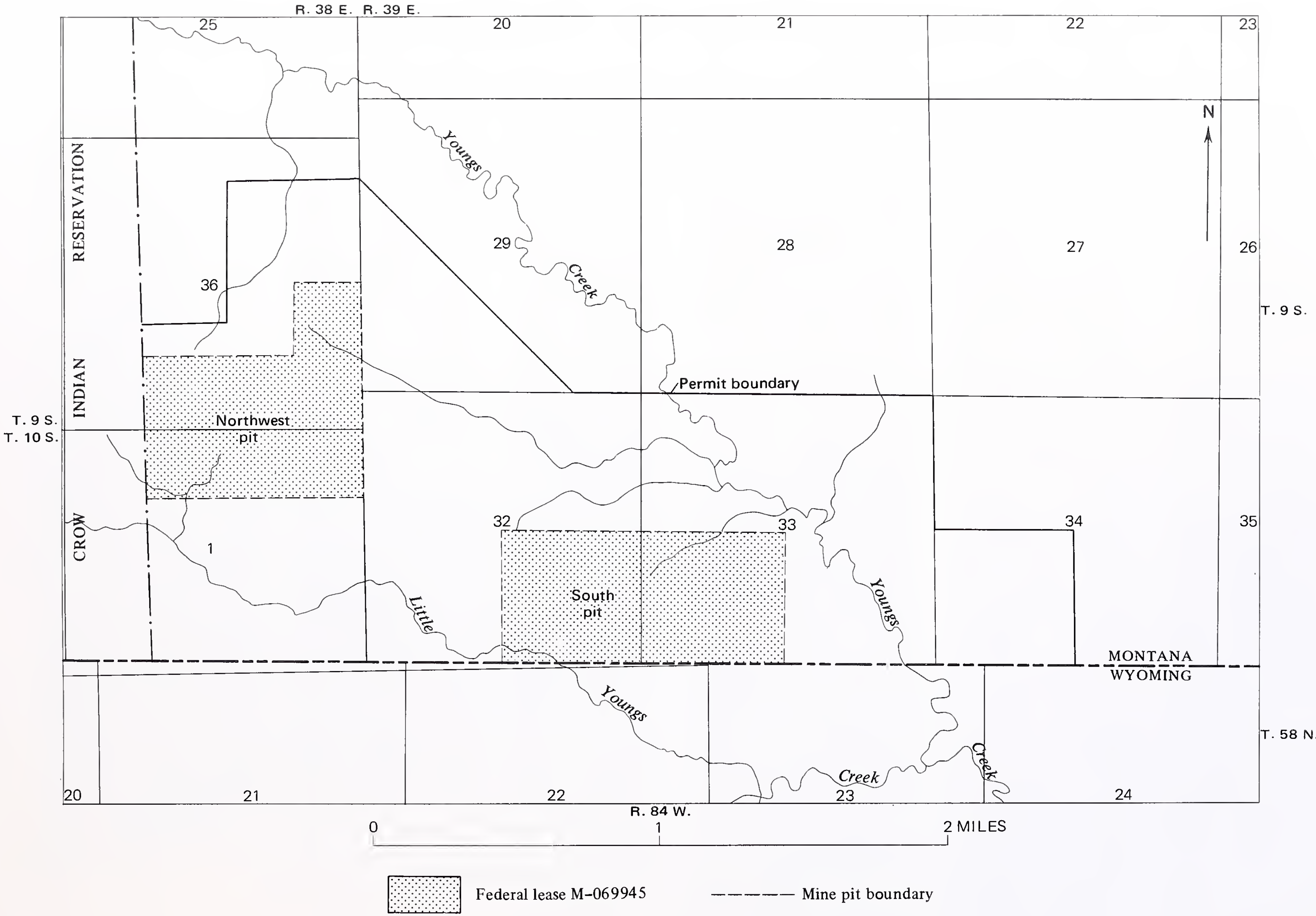


Figure I-3.—Areas to be mined.

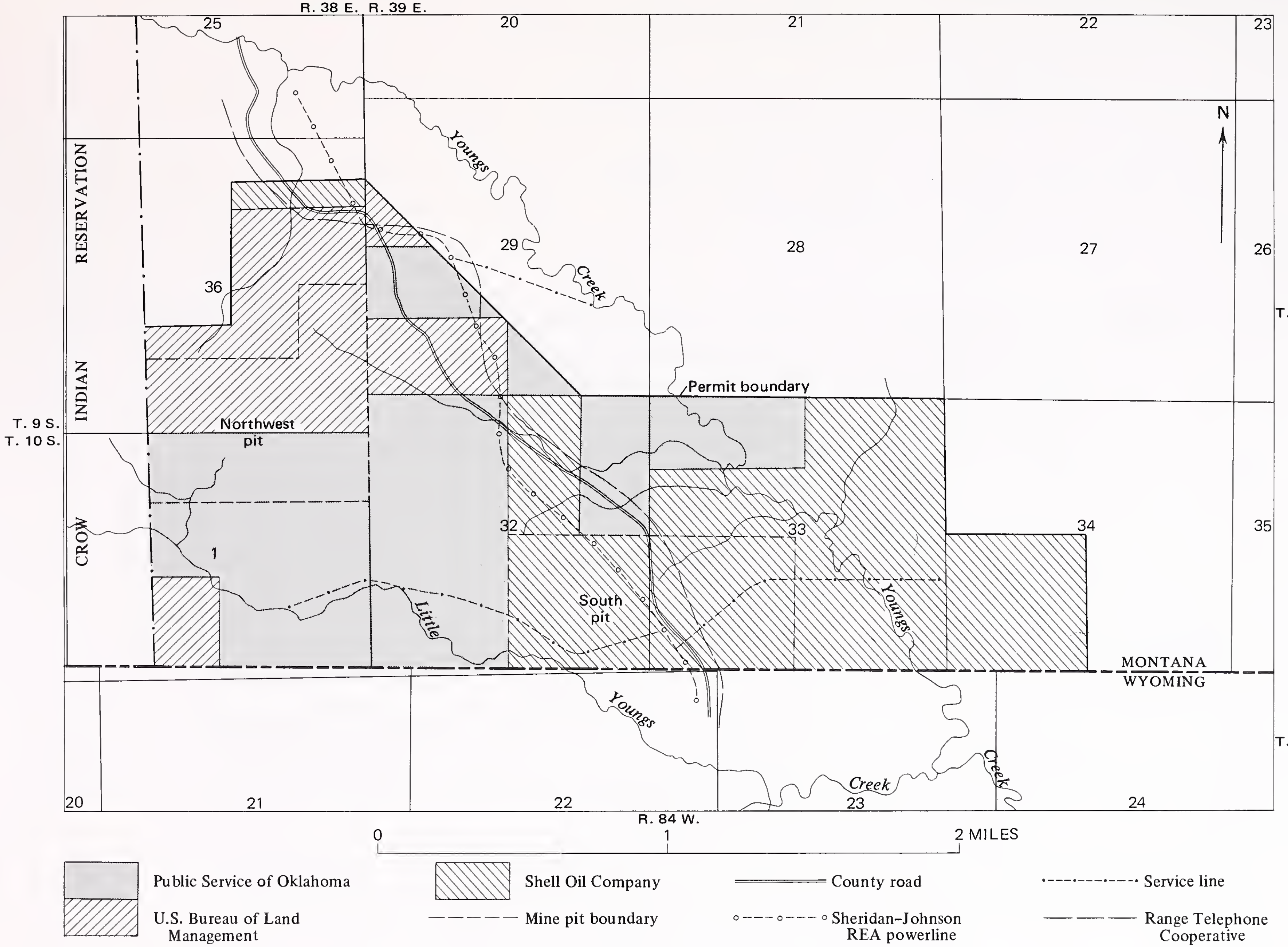


Figure I-4.—Surface ownership and rights-of-way.

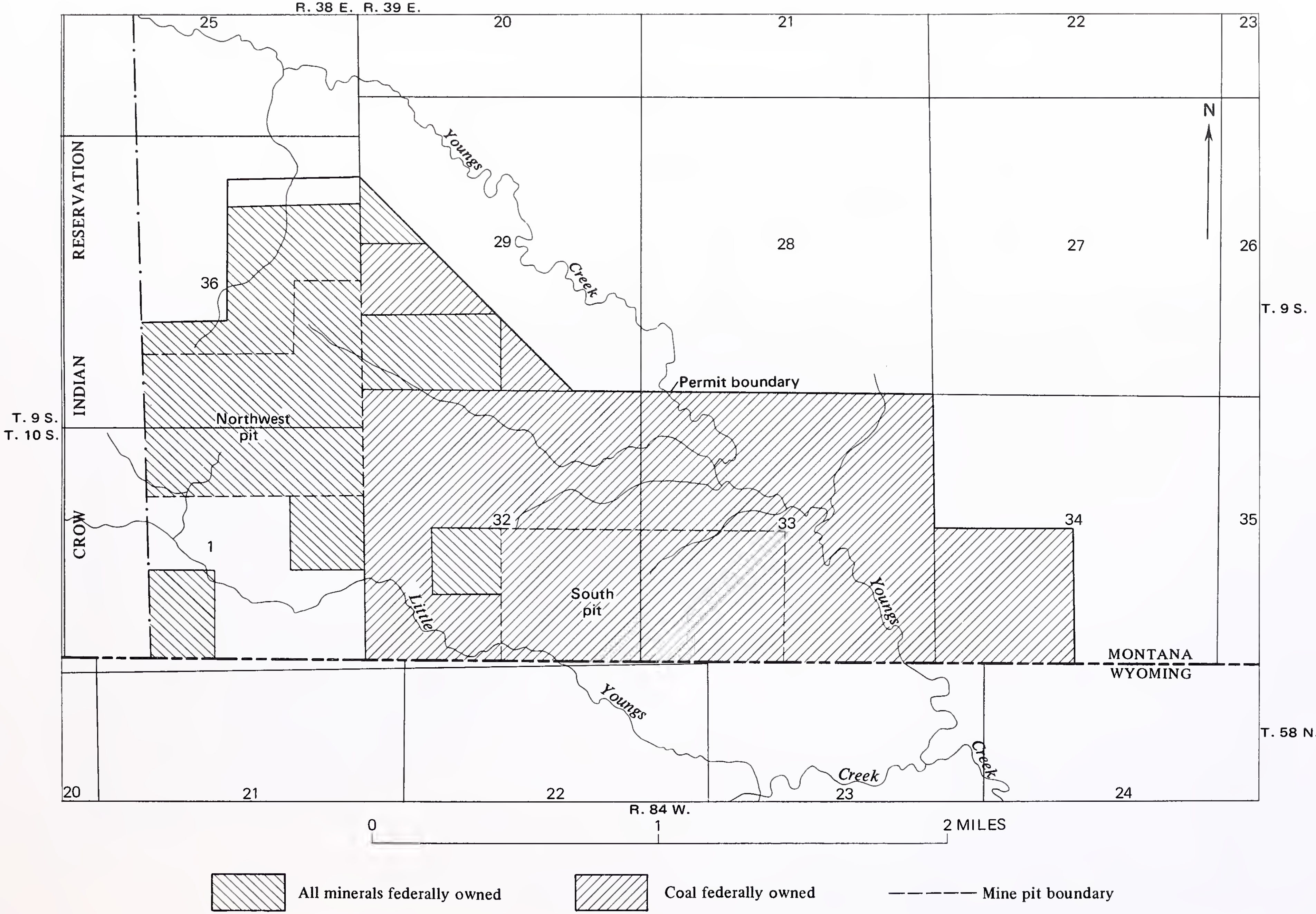


Figure I-5.—Federal mineral ownership.

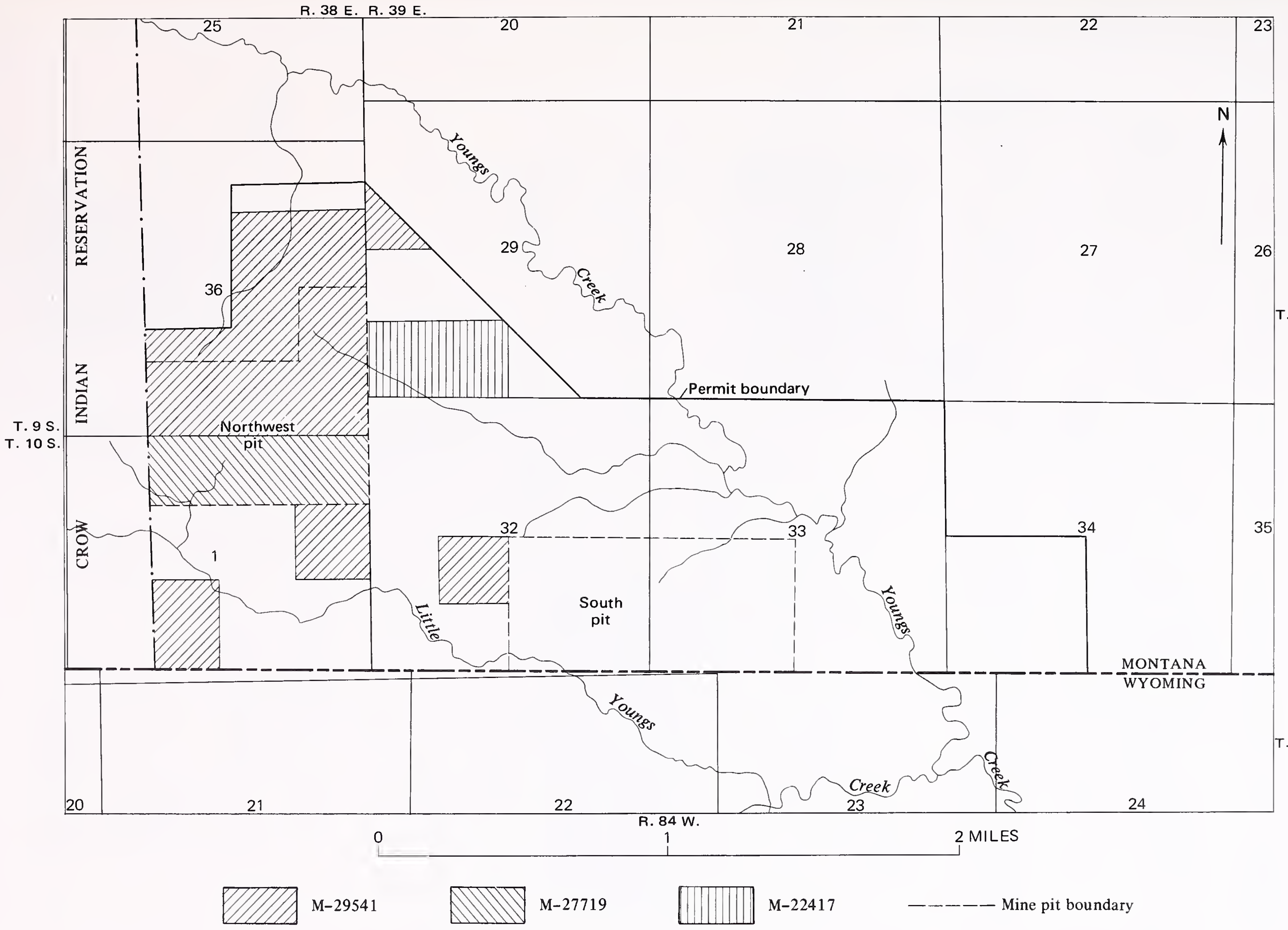


Figure I-6.—Federal oil and gas leases in the Pearl area.

Creek empties into Youngs Creek just southeast of the mine, and Youngs Creek empties into the Tongue River. Both creeks are on alluvium.

The Pearl area is characterized by low rolling hills and buttes. Prairie grasses and sage dominate the vegetation, but stands of evergreens are scattered throughout. The climate is semiarid and the area generally uninhabited. One family lives in the vicinity of the proposed mine. The land in the mine area is used for wildlife habitation, domestic stock grazing, and minimal dry-land or irrigated farming.

The nearest major town is Sheridan, Wyoming, approximately 12 miles to the south. The main access to the mine is an existing county road from Highway 338. This road crosses the south tract of the lease; hence, Shell would be required to relocate 3.8 miles of road prior to mining (fig. I-7).

E. COAL RESERVES

About 60 million tons of coal lie beneath the lease. The coal, part of the Tongue River Member of the Fort Union Formation, has been analyzed from 29 exploratory holes in the two tracts. Supporting data has been analyzed by drilling over 50 holes in contiguous sections. Because of geologic abnormalities, lease line setback, and the angle of pit slopes, the coal recovery would be approximately 46.5 million tons (about 78 percent).

Seven seams have been identified: in descending order, the A, C, D, G, M, O, and R seams (table I-2). The A and C seams occur only in the northwest tract. These seams will be mined where practical. The D, G, and M coal seams are of principal interest, because they are economically feasible to mine. The D seam, the shallowest, occurs only in the south tract and is usually encountered only in the topographic highs, where the overburden above the G seam is approximately 200 feet. The G and M seams underlie the entire area. The O and R seams also underlie the entire mine area but are at depths which preclude surface development. A maximum overburden depth of 400 feet represents a reasonable mining limitation at this time. Approximately 82 feet of coal would be recovered with a stripping ratio (yd^3 of overburden/ton of coal) of about 4:1.

TABLE I-2.--Coal seams in the Pearl area

Seam	Decker designation	Depth (feet)	Thickness (feet)	Location
A--	Roland--------------	100	8-12	Northwest tract.
C--	Squirrel Creek------	100	2-5	Northwest tract.
D--	Smith---------------	100	2-26	South tract.
G--	Anderson-Dietz No. 1	100-39	25-57	Both tracts.
M--	Dietz No. 2---------	200-500	12-28	Both tracts.
O--	Canyon (Monarch)----	380-680	14-22	Both tracts.
R--	Wall (Carney)-------	425-745	11-28	Both tracts.

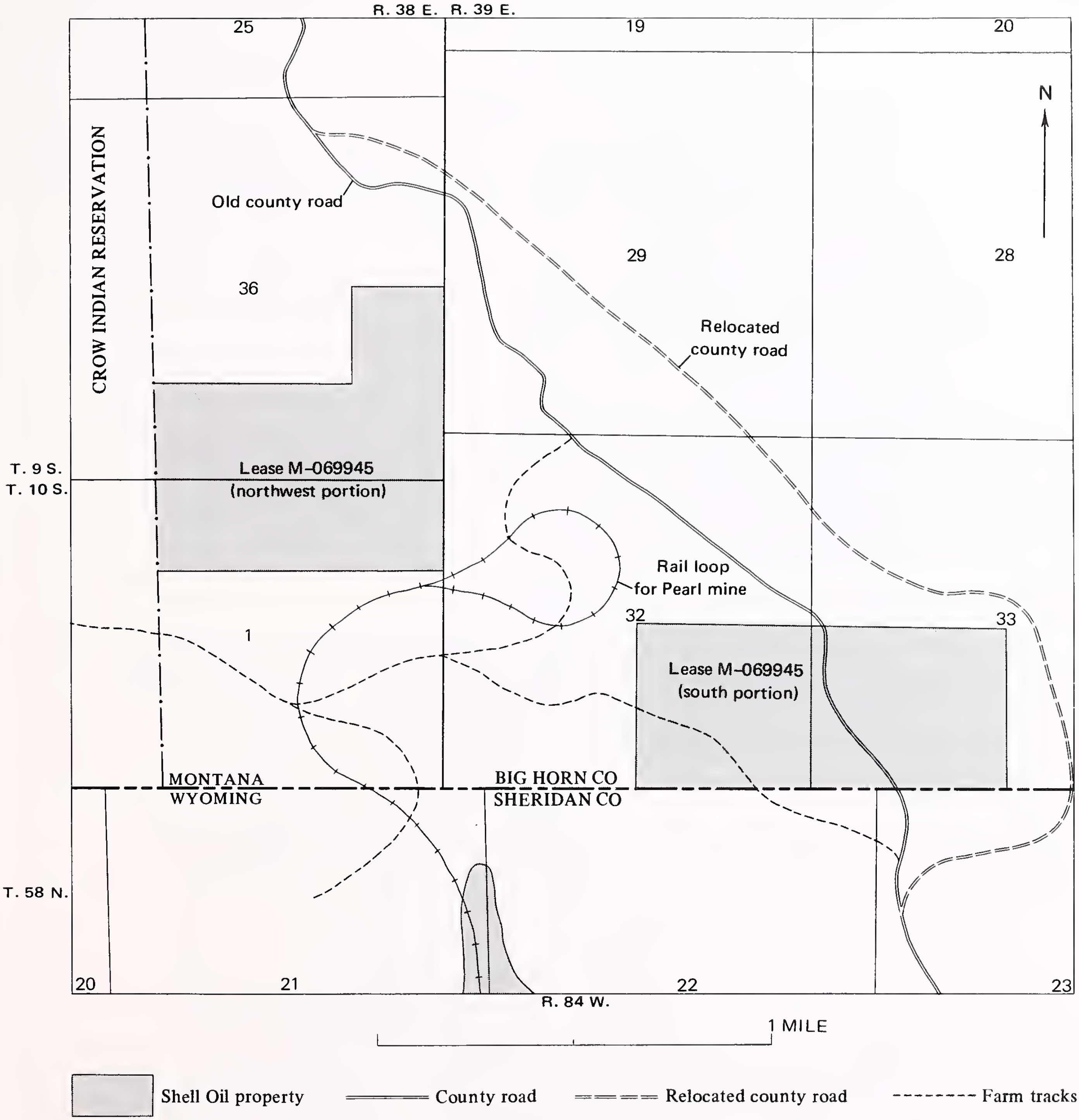


Figure I-7.—Roads and railspur.

Average values from core analyses of economically recoverable coal are tabulated as follows:

Rank: Subbituminous C

[Shown on an "as received" basis]

Seam	Btu	Percentage Sulfur	Moisture	Ash	Volatiles	Carbon
C---	8099	1.79	26.51	8.23	30.31	34.95
D---	8463	0.86	23.75	3.44	34.17	38.64
G---	8943	0.40	23.67	5.85	32.19	38.29
M---	9519	0.43	22.76	3.50	34.02	39.72

Laboratory analyses indicate that both the C and D coal seams have a higher sulfur content/million Btu's than would meet compliance standards; hence, they would be mixed with the lower sulfur G and M coals. The C coal seam is not present in the south tract.

F. FACILITIES

Mine facilities would be constructed on land between the two tracts where no economically strippable coal exists (fig. I-8). These facilities would include a railroad spur and loop, haul roads, coal handling and loading facilities, storage facilities for fuel and explosives, a mine office building, a change house, and a shop-warehouse. The buildings would be prefabricated, rigid-frame structures. A guard house and chain-link fence would control access to the facilities. High-use areas would be illuminated by mercury vapor lamps at night. The proposed mine and coal-crushing facilities would require electric power, industrial and potable water, and waste disposal.

1. Railroad Spur and Loading Area

The railroad spur serving the minesite would connect to the Decker spur in Wyoming, approximately 15 miles southeast of the lease (fig. I-9). The right-of-way would be 200 feet wide in the one-half mile wide corridor Shell has obtained for the purpose. Track and roadbed construction would conform to Burlington Northern Railroad standards. The railspur would end in a loop to facilitate rapid loading of about 4 unit trains per week (100 rail cars at 100 tons each). The loadout station would consist of two overtrack storage silos. A short length of track on the east side of the loop would be used to unload materials and supplies. Following mining the silos and railroad loop would be used by other mines built in the area. When no longer needed they would be removed and the area reclaimed.

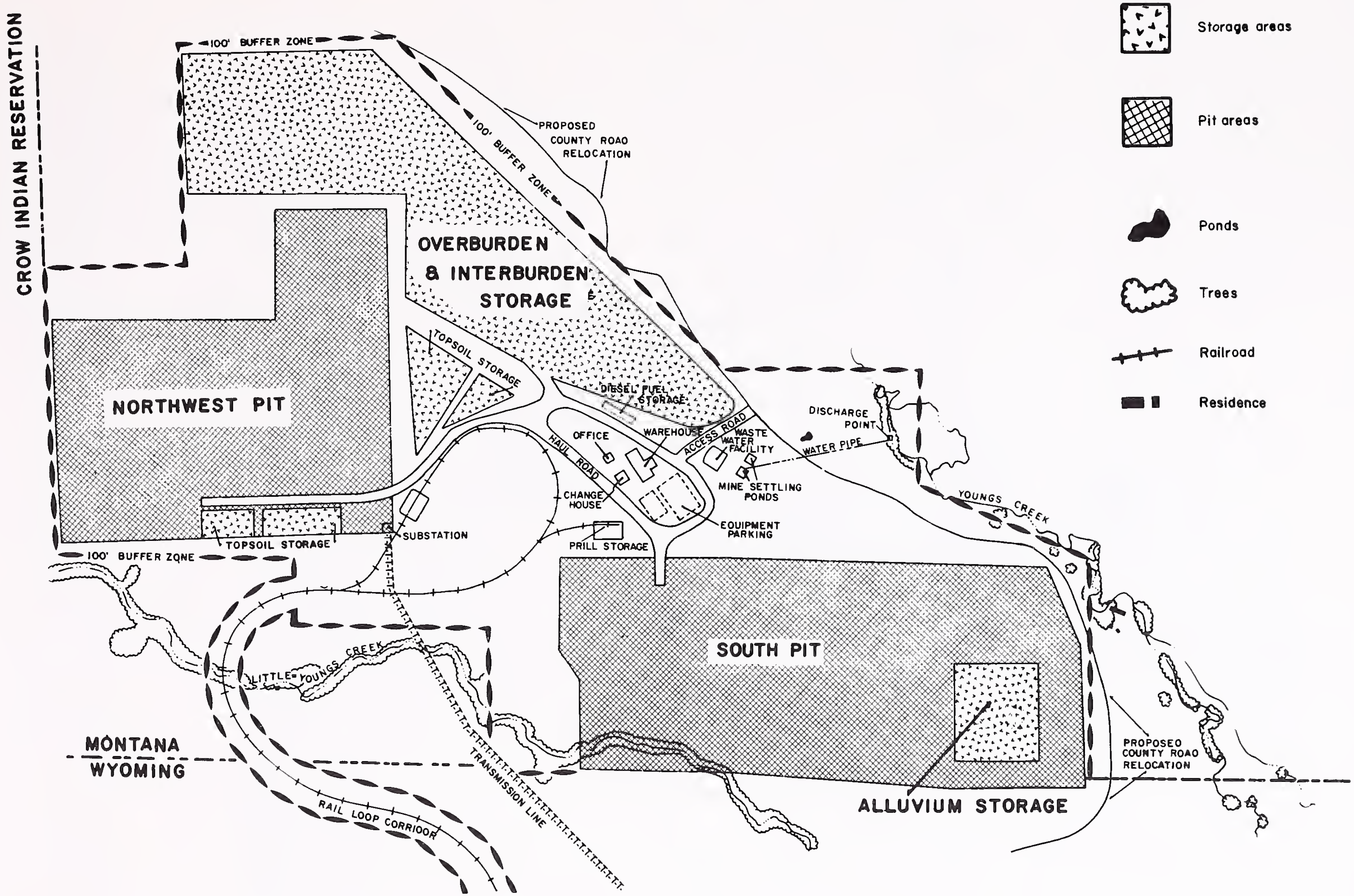
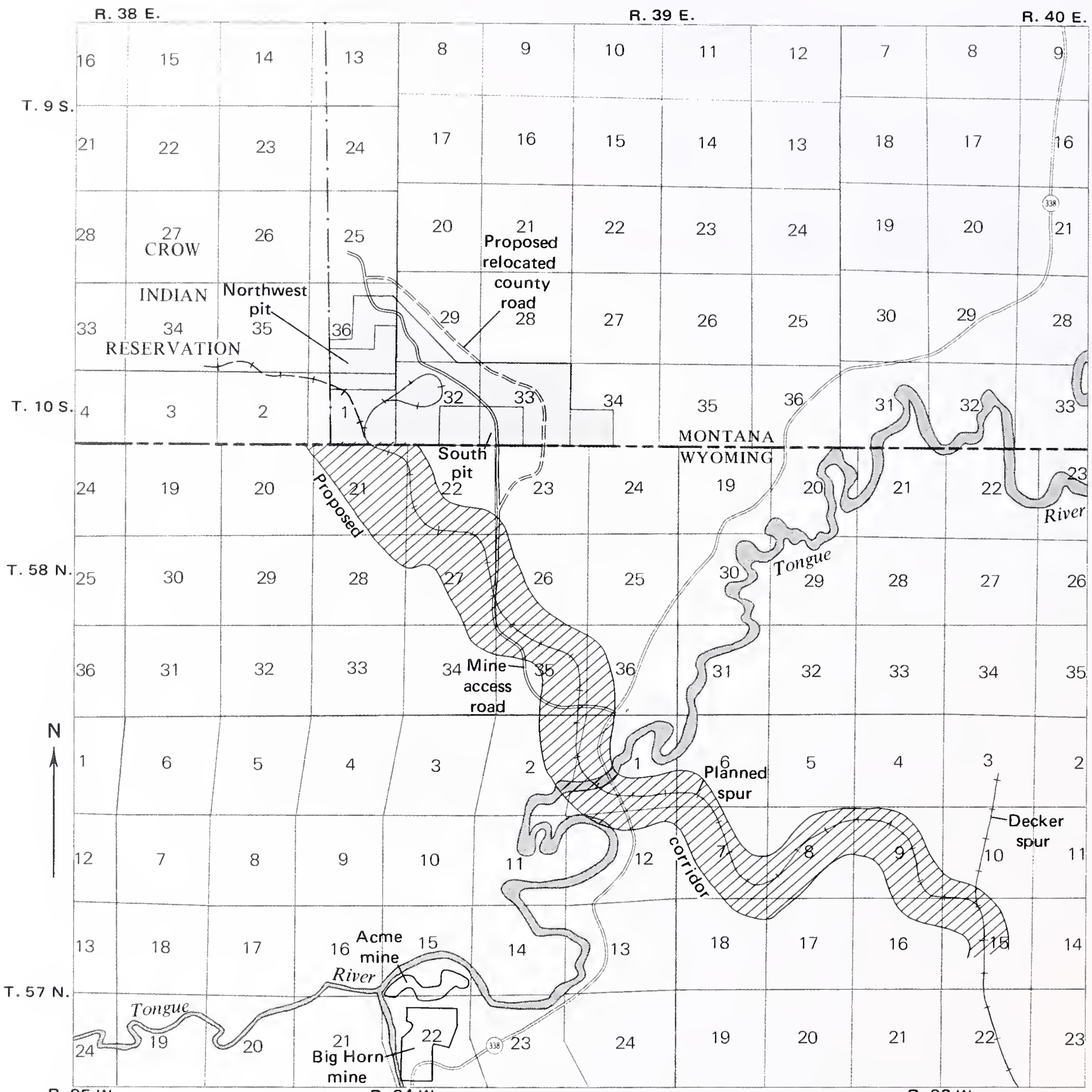


Figure I-8.—Facilities location for Pearl mine.



Source: Montana Testing Laboratories, Inc., Helena, Montana. L. Dean Culwell, Patrick Farmer, March, 1976.

Figure I-9.—Proposed railroad corridor.

2. Haul Roads

All haul roads would be 80 to 100 feet wide and would be surfaced with clinker. Topsoil would be removed from the roads and stored before the roadbed material is placed. Surface runoff would be controlled by drainage ditches along the roadway, and a water spray truck would be used to control road dust when required. The water would be obtained from impoundments within the mine area and from mine effluent. When mining is completed, all haul roads would be ripped, leveled, and revegetated. Powerlines and other associated equipment would be removed.

3. Coal Handling and Storage

The coal-handling facilities would include truck dump, crusher, conveyors, sampling station, and storage silos. Coal would be transported from the pit area in 120-ton end dump trucks and dumped at the grizzly, and passed by gravity to the crusher, where it would be reduced to less than 2 inches in size. An elevated belt conveyor would then transport the crushed coal to the top of the train loadout station. This station would include two silos approximately 80 feet in diameter and 180 feet high, providing a total capacity of 25,000 tons. This tonnage would be equivalent to 6 days of shipments during the first year of operation and 3 days thereafter. An automatic coal sampling station would be on top of the silos. Sample rejects would feed back to the storage silos. Dust from the crusher would be controlled through the use of enclosed structures and/or collection devices, as required by the regulations and permit stipulations.

4. Fuel and Explosives Storage

Diesel fuel (2,403,200 gal. annually), for mobile equipment and ammonium nitrate prills, would be delivered in rail cars and stored in three 1,500-gallon above ground tanks. Gasoline would be delivered by truck and stored in underground tanks adjacent to the diesel storage area. Gasoline consumption is estimated to be 50,000 gallons per year.

Class "A" explosives (dynamite, precast primers, and primacord) would be stored in portable type-2 skid-mounted enclosures. Class "C" explosives (nitro carbonitrate) would be stored in separate enclosures. Ammonium nitrate prills would be stored in silos next to the siding, east of the railroad loop (fig. I-8). Average explosive consumption is estimated estimated at 4 million pounds per year.

5. Other Structures

Other structures (fig. I-8) would include: a mine office building, a change house with bath facilities and adequate locker space to accommodate the total work force; and a shop-warehouse building with four drive-through bays for truck and heavy-equipment maintenance and repairs.

6. Power Supply and Distribution

Electric power would be supplied by the Tri-State Generation and Transmission Association. A 13.8-kV feedline would be installed between the existing Decker powerline (approximately 7 miles southeast of the property) and a new substation on the northwest tract (fig. I-8). A new transformer would be installed at the main line connection to reduce the high voltage to 13.8 kV for the feed line.

The feed line would extend from the new substation to the mine office area and then on to the south tract. "Stub" lines would connect the feeder to portable transformers, and flexible cables would distribute power from the transformers to the mining equipment. All powerlines would conform to REA Standards for protection of birds against electrocution. Estimated power consumption would be about 11,000,000 kWh/year maximum.

7. Water Requirements

Total industrial water consumption at full production is estimated at 20,000 gallons/day as follows:

	Gal/day
Dust control---------	14,000
Equipment washdown---	2,800
Sanitary facilities--	3,200
Total--------	20,000

This water would come from mine effluent and from wells. Either the M seam, its adjacent sandstones, or a lower coal seam would probably be a source of potable water. The plant area would be the preferred location for the water well or wells; the number of wells would depend on the yield of the aquifer selected.

8. Sewage Disposal

A central sewage treatment plant would be constructed at the minesite, adequate to handle the office and shop areas. The settling ponds would be designed for adequate retention time to eliminate any sediment that would discharge into Youngs Creek; the treated water would meet State and Federal standards.

G. MINING ACTIVITY

The design criteria to be employed for designing mining and reclamation at the Pearl area represent some of the most desirable. The maximum practicable recovery of coal would be assured by: (1) locating the mine facilities on surface not underlain by economically strippable coal;

(2) mining to the coal burn line; (3) designing and maintaining the maximum economic stripping ratio; and (4) using mining and spoiling techniques that would allow 90 to 95 percent recovery of the mineable coal.

1. Employment Schedule

A construction work force of approximately 200--higher than that required for a dragline operation of comparable size--is estimated for the 2 years preceding mining. This number may vary considerably depending on weather, contractor's production schedule, and availability of manpower. Coal production would begin with 116 permanent employees, increasing to 136 for the second through the twenty-fourth year of the productive life of the mine. The last 3 years of operation would be devoted to backfilling and reclamation. The anticipated employment schedule is summarized as follows:

[Source: Shell Oil Company]

	Construction		Production-reclamation		
Year:	-2	-1	1	2-24	25-27
Construction employees------	200	200	-	-	-
Salaried mine employees-----	5	22	33	33	15
Hourly mine employees-------	-	35	83	103	35
Total---------------------	205[1]	257	116	136	50

2. Public Safety

Access to the mine and facilities areas would be controlled by fencing. The operator would allow public access for legitimate purposes that would not interfere with mining operations. If public access should interfere with wildlife or livestock grazing, revegetation, or reclamation, or present a hazard to public safety, the company would provide warnings, barricades, fencing, or flagmen to control access. A blasting schedule would be posted or published to warn nearby residents and local governments.

3. Mine Layout and Sequence of Mining

Prior to mining, Little Youngs Creek would be diverted away from the south pit and into the diversion ditch built for the Ash Creek mine. Mining would commence at the west edge of the south pit (fig. I-10). The silts and clays, and the gravel of the alluvium would be selectively salvaged and stockpiled on the west end of south tract. The overburden would be removed by truck and shovel and stockpiled (fig. I-8) for filling the final cut of the northwest pit (fig. I-11). After the initial cut was completed, a second cut would be opened and the overburden would be used to backfill the initial cut. The alluvium would then be selectively replaced on top of the backfilled overburden to restore the premining

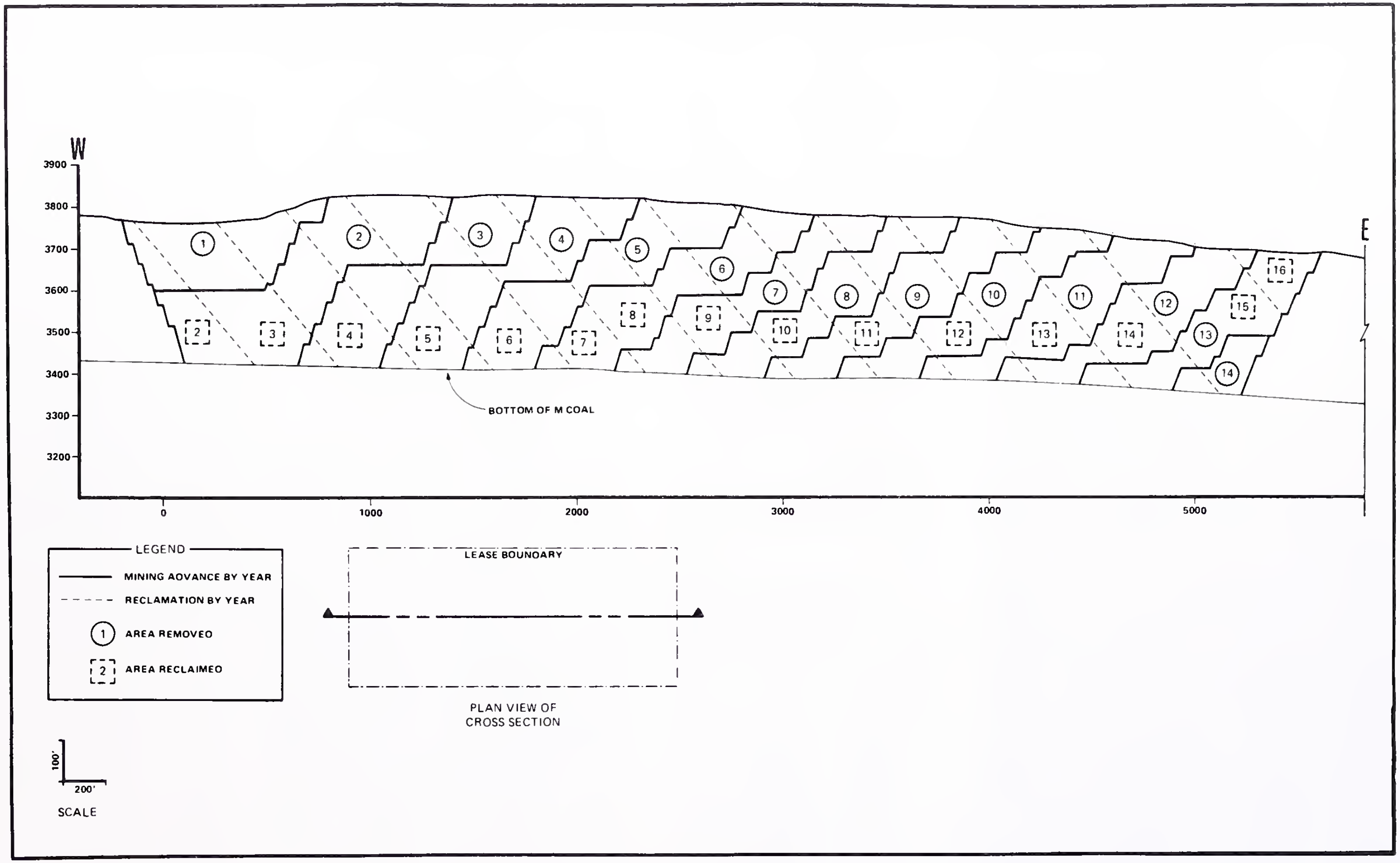


Figure I-10.--Longitudinal cross section, south pit.

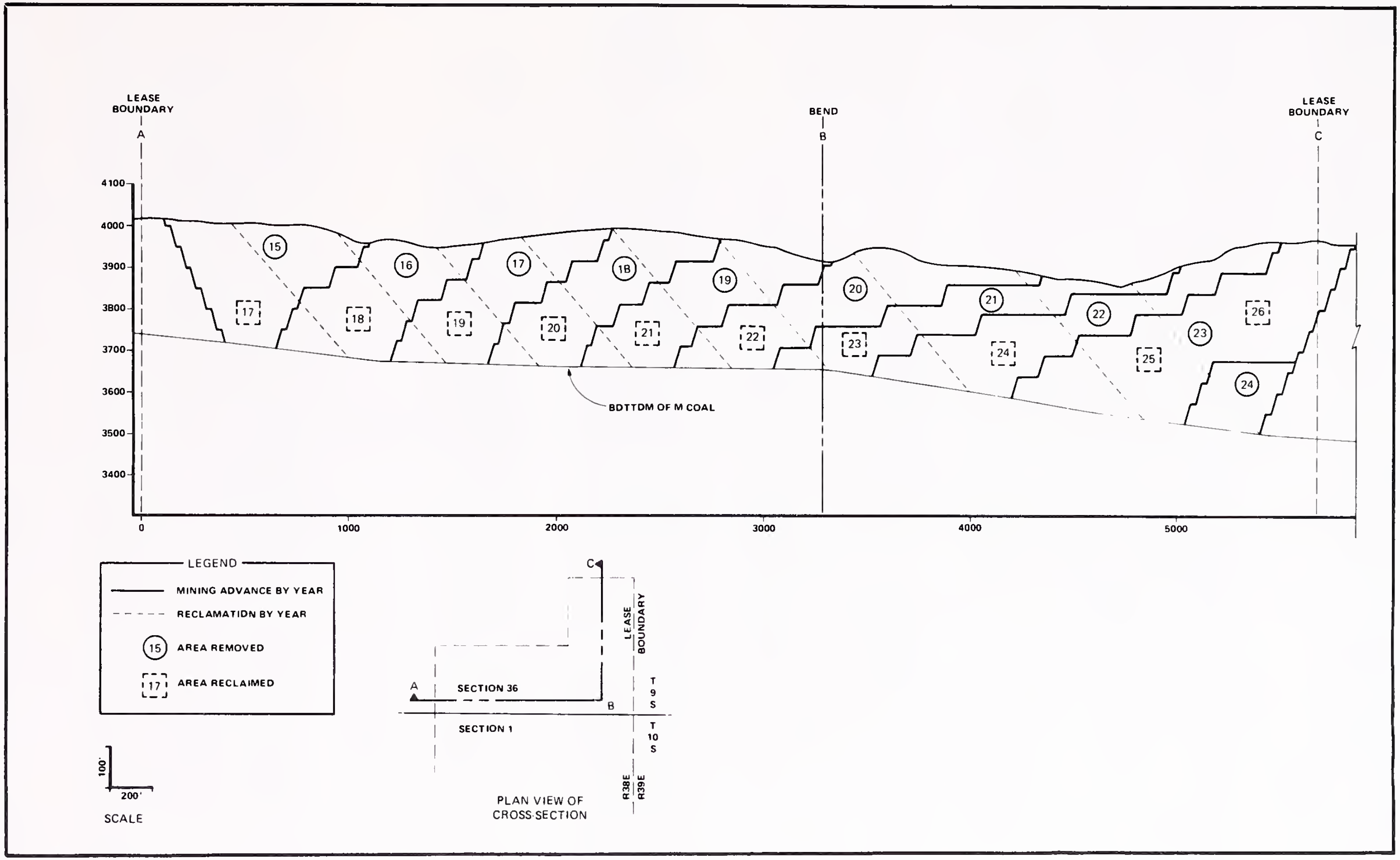


Figure I-11.–Longitudinal cross section, northwest pit.

contours. Mining would advance eastward in this manner. As the bottom bench of each cut was approached, mining would begin on the top bench of the next cut to the east. The company proposes to overstrip, that is, to strip beyond the lease boundary, and into the permit area to maximize the recovery of coal.

In the 14th year the south pit would be depleted and the mining operation moved to the northwest tract. The initial cut in the northwest tract would be at the west edge of the area (fig. I-11) and the overburden would be used to backfill the final cut of the south pit. The next cut would be immediately east of the initial cut. As mining advances eastward, however, each succeeding cut would trend more to the northeast than the preceding cut. In this manner the final cut would be in the northeast corner of the tract. This mining sequence would facilitate continued mining if Shell were able to obtain control of coal reserves adjoining this tract to the north and east.

The total area disturbed by mining would be approximately 616 acres (fig. I-12, I-13). Additional surface disturbance is estimated as follows: stockpiles, 300 acres; surface facilities, 260 acres; and road relocations and railroads, 20 acres. Total affected areas would be approximately 1,196 acres; however the company is permitting an additional 266 acres surrounding the actual disturbance (a total of 1,462 acres).

Water that accumulates in the mine area would be pumped to a settling area before being returned to the natural drainage system. Sediment would be collected in ponds (fig.I-8), and, if necessary, chemicals would be used to purify discharge waters. Mine water would be discharged into Youngs Creek in section 33, T. 9 S., R. 39 E.

There would be no siltation structures within the minesite. Ditches, constructed where water control is needed, such as along haulage roads and in the facility site, would be designed and constructed for control of anticipated water inflow.

a. Topsoil removal

Topsoil[1] would be removed from all affected areas before construction and mining; redistribution would normally occur in a continuous process prior to the spring and fall planting seasons. "Topsoil" stockpiles (fig. I-8) would be located away from overburden stockpiles and would be stabilized using mulches and quick growing annual and perennial plants.

Because topsoil in desirable quantities is limited, all soils of acceptable quality would be saved for use. The top 6 inches of soil

---

[1]Topsoil as used here is any material derived from the original soils profile, and capable of supporting plant growth. Double-lift salvage separates the top 6 inches from the subsurface soil. This corresponds roughly to "A" horizon and "B" and "C" horizons materials, respectively.

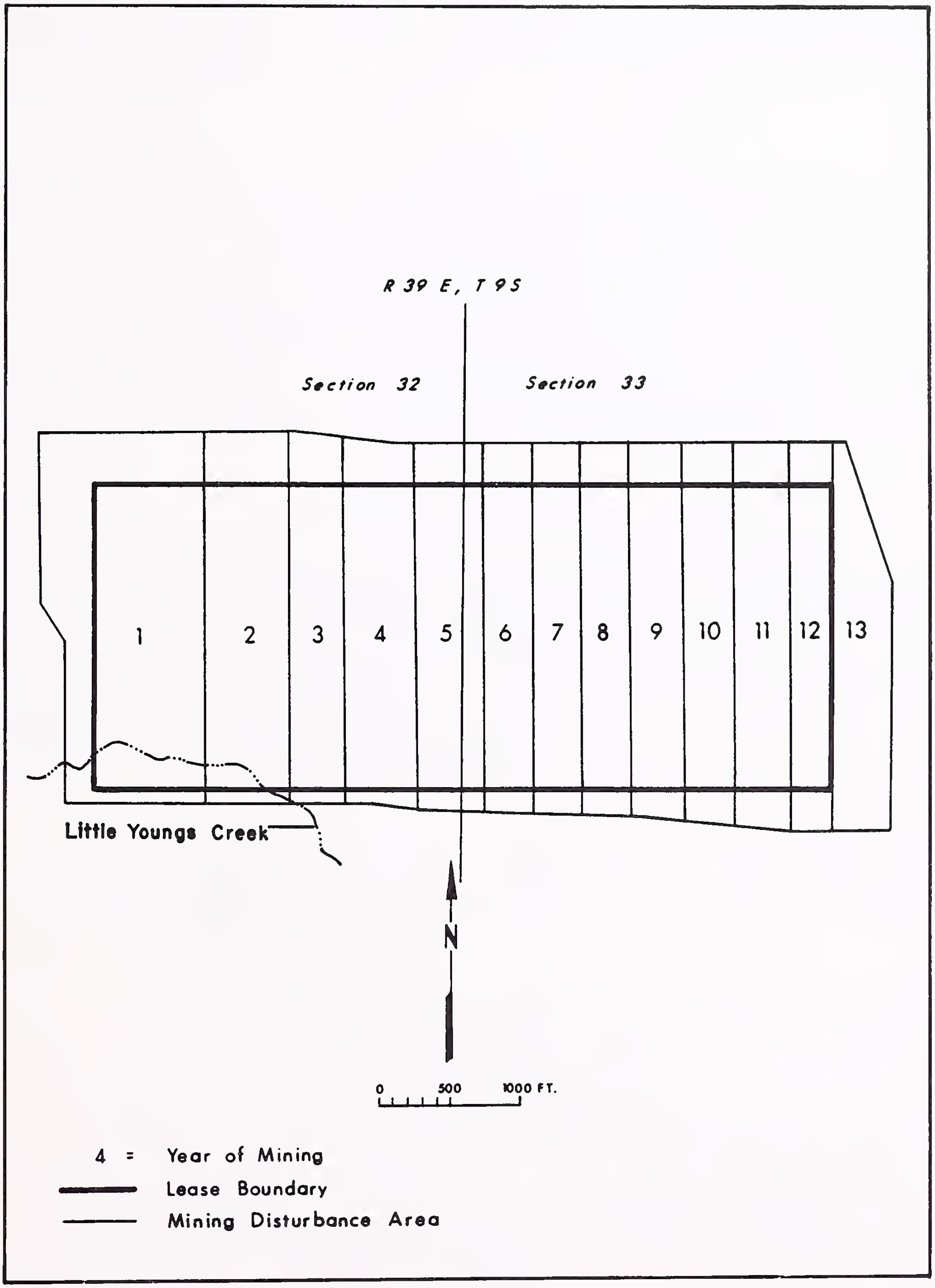


Figure I-12.—Annual mining disturbance, south pit.

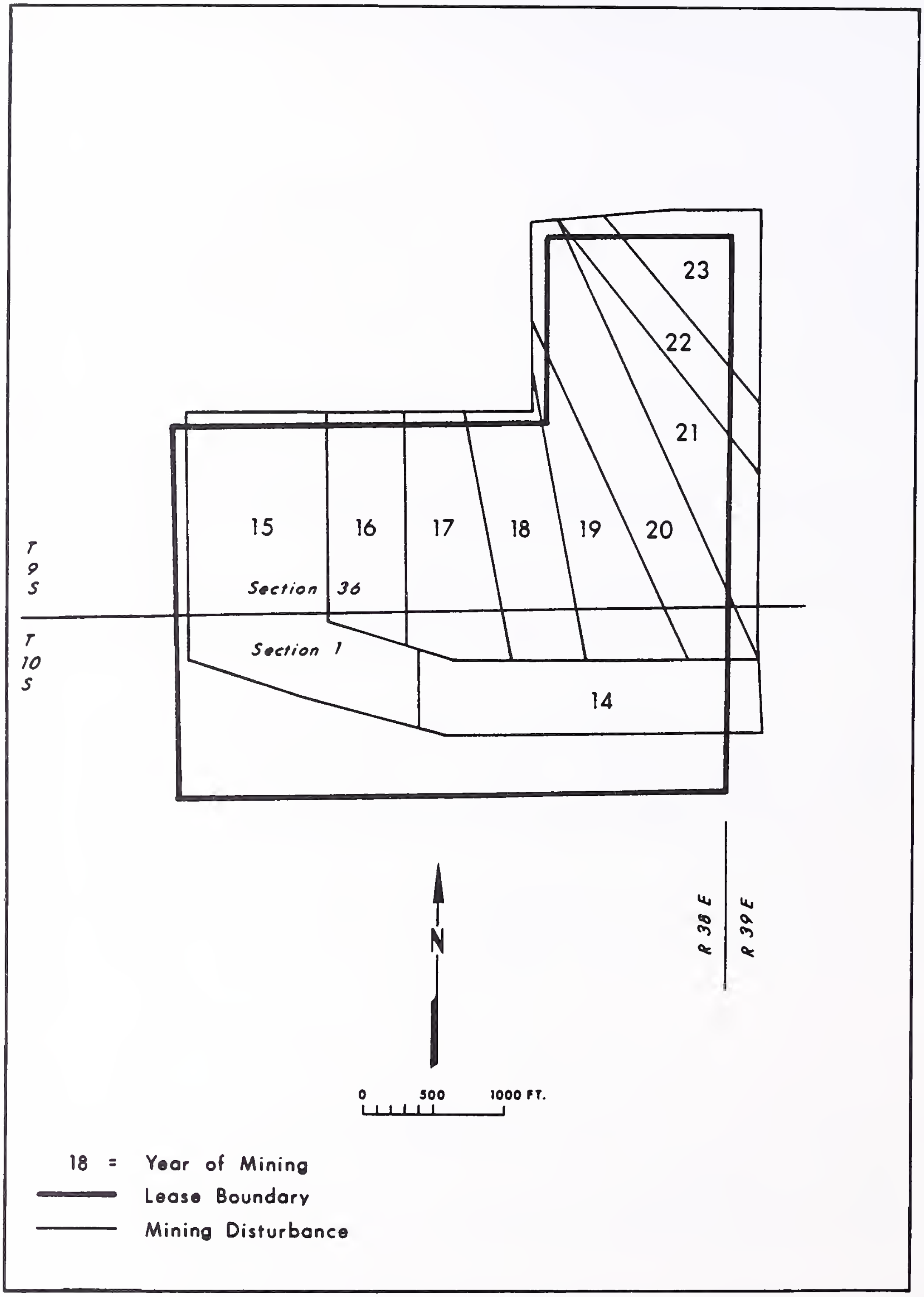


Figure I-13.–Annual mining disturbance, northwest pit.

would be salvaged first. The remaining salvageable soil, deeper than 6 inches) would be retrieved separately. Clinker and the coarser soils would be salvaged for use as a substrate in reestablishment of Ponderosa pine and skunkbush sumac.

b. Overburden removal and storage

The overburden, silty and sandy shales, with interbedded sandstone and siltstone, would be removed in 50-foot benches (figs. I-10, I-11). Spoils and slack coal from the initial cut in the south tract would be segregated and stockpiled in the area designated in figure I-8. Runoff and sediment from the stockpile would be prevented from flowing off the permit area. The stockpiled overburden and slack coal would be used to fill the final cut of the northwest pit when mining is completed. Any potentially toxic or undesirable over- and interburden materials would be selectively buried below the rooting depth of the vegetation.

c. Coal mining, loading, and hauling

Coal would be removed from the pit in the same manner as the overburden--by stepwise excavation of the coal seams as the pit deepens. Drilling and blasting would be used to loosen the coal. Blastholes would probably be drilled on a 20-foot grid and be loaded with ANFO (ammonium nitrate-fuel oil) mixture. Front-end loaders would load 120-ton end dump trucks. The estimated yearly rates for both overburden removal and coal production are shown in table I-3.

4. General Reclamation Proposal

To the extent possible, reclamation would proceed concurrently with mining, and topsoil stockpiling would be minimized as much as possible. Reclamation would progress continuously from the second year of mining until 3 years after mining is complete.

At the completion of mining, the land would be returned to its prior condition to be used by wildlife and ranchers (livestock, and, along the bottom lands, hay production). The land surface would be recontoured to approximate the original topography. Drainage channels would be relocated to approximate their original location and would be stabilized by sodding and by tree and shrub plantings. The disturbed areas would be seeded with a mixture of predominantly native grasses, forbs,and shrubs, and would be mulched to prevent erosion. The land surface would be managed until the new vegetation becomes established. Shrubs and trees would be placed on topographic highs and in draws to simulate the preexisting vegetation.

Mining in the south tract would be completed during year 14; reclamation would continue into year 16. Mining in the northwest tract would be completed in year 24, and reclamation would continue through year 27. Reclamation of the stockpile area would begin as the material

TABLE I-3.--Coal production, in thousands of tons

[Source: Shell Oil Company]

Year	Overburden moved[1]	Coal seam recovered C	D	G	M	O	R	Total rec.	Strip ratio[2]
1	9,003.9	---	---	258.8	804.3	---	---	1,063.1	8.47
2	12,851.7	---	47.9	332.8	617.1	568.2	463.9	2,029.9	6.33
3	10,094.2	---	71.6	631.0	1,022.5	140.2	196.8	2,062.1	4.90
4	11,788.4	---	86.9	702.0	1,146.6	79.7	125.3	2,140.5	5.51
5	11,893.3	---	92.0	769.0	1,073.6	30.7	46.0	2,011.3	5.91
6	10,811.2	---	89.5	784.8	1,184.5	---	---	2,058.8	5.25
7	10,652.2	---	159.8	780.9	1,124.7	---	---	2,065.4	5.16
8	9,701.9	---	117.2	717.3	1,232.4	---	---	2,066.9	4.69
9	11,257.7	---	126.8	757.2	1,143.9	---	---	2,027.9	5.55
10	9,031.3	---	111.8	652.2	1,285.4	---	---	2,049.4	4.41
11	9,874.8	---	121.4	717.8	1,184.5	---	---	2,023.7	4.88
12	8,919.7	---	32.6	749.3	1,285.4	---	---	2,067.3	4.31
13	6,968.4	---	---	562.0	1,511.7	---	---	2,073.7	3.36
14	6,427.9	---	---	321.4	1,813.0	---	---	2,134.4	3.01
15	13,074.3	83.5	114.5	737.5	1,054.4	---	---	1,989.9	6.57
16	7,547.0	53.2	97.0	661.6	1,185.0	---	---	1,996.8	3.78
17	7,737.0	44.4	87.5	672.9	1,214.2	---	---	2,019.0	3.83
18	7,627.2	42.5	91.1	679.1	1,191.3	---	---	2,004.0	3.81
19	7,349.3	11.0	100.1	683.3	1,207.8	---	---	2,002.2	3.67
20	10,055.9	38.0	107.0	687.7	1,207.8	---	---	2,040.5	4.93
21	5,902.1	11.9	55.9	782.0	1,204.7	---	---	2,054.5	2.87
22	5,646.1	35.6	107.4	732.0	1,218.3	---	---	2,093.3	2.70
23	7,278.0	16.4	176.0	785.1	1,072.2	---	---	2,049.7	3.55
24	940.7	---	---	---	577.4	---	---	577.4	1.63
Total-	212,434.2	336.5	1,994.0	15,157.7	27,562.7	818.8	832.0	46,701.72	4.55

[1] Bank cubic yards x 1,000.
[2] Bank cubic yards/ton.

is removed and would continue until completed in year 27. The schedule for annual surface disturbance and reclamation is shown in table I-4.

a. Shaping of overburden

Backfilling in the mined-out west end of the south tract would begin in year 2. Bulldozers and graders would shape the topography to the designed specifications under surveyed field control. Large scrapers would be used to add or remove material where dumping with trucks could not approximate the shape.

TABLE I-4.--Surface disturbance and reclamation schedule

Year	Disturbed: Annual acres	Disturbed: Accumulative acres	Reclaimed: Annual acres	Reclaimed: Accumulative acres	Unreclaimed
1---	66	66	---	---	66
2---	37	103	---	---	103
3---	24	127	25	25	102
4---	30	157	19	44	113
5---	30	187	26	70	117
6---	21	208	14	84	124
7---	22	230	18	102	128
8---	21	251	20	122	129
9---	25	276	18	140	136
10---	22	298	22	162	136
11---	26	324	18	180	144
12---	19	343	21	201	142
13---	20	363	22	223	140
14---	25	388	21	244	144
15---	52	440	33	277	163
16---	20	460	54	331	129
17---	24	484	50	381	103
18---	21	505	20	401	104
19---	22	527	23	424	103
20---	33	560	22	446	114
21---	21	581	26	472	109
22---	15	596	21	493	103
23---	20	616	20	513	103
24---	---	616	19	532	84
25---	---	616	25	557	59
26---	---	616	31	588	28
27---	---	616	28	616	---

No slopes would be steeper than 5:1. Similar drainage patterns would replace those removed by mining. Replaced material would be compacted by settling and by heavily loaded equipment. The proposed final topography is shown in figures I-14 and I-15. (See fig. I-2 for existing topography.)

Should delays occur in the placement of topsoil, the company would be required by law to temporarily stabilize the backfilled areas. The company would do this by planting annuals, such as barley, or by mulching.

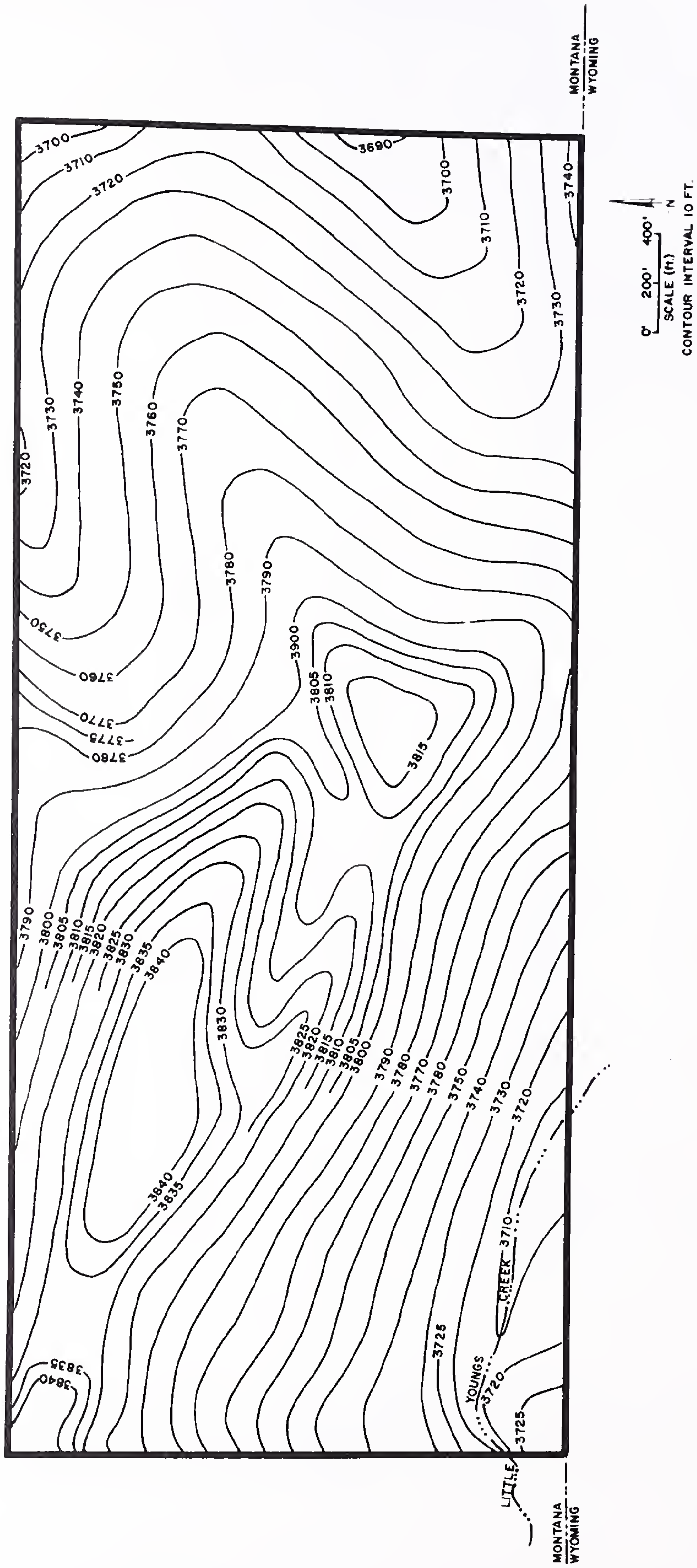


Figure I-14.–Postmining contours for the south pit.

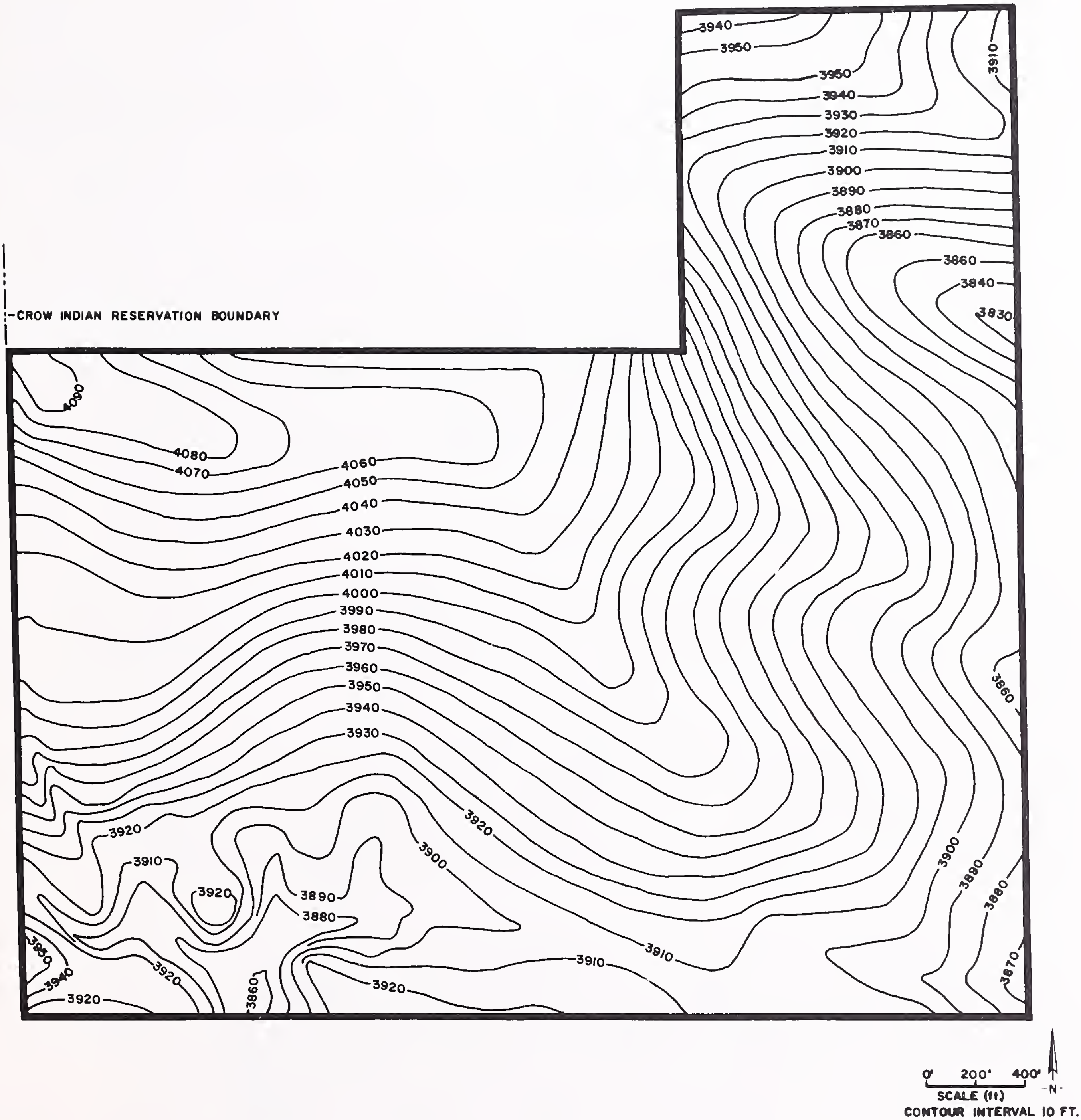


Figure I-15.—Postmining contours for the northwest pit.

b. Placement of topsoil

In general, topsoil would be removed and immediately placed on overburden that has been backfilled and shaped, but in some instances preplanned stockpiling of topsoil would be necessary. Topsoil would be redistributed on the contoured fill with scrapers and shaped with graders. Topsoil would be applied only in the spring or fall when it can be seeded under favorable moisture conditions. Wind erosion would be reduced by mulching.

Six to 10 inches or more of topsoil would be applied over a suitable layer of overburden and interburden buffer material. Finer textured topsoils would be placed on swale bottoms and coarser textured soils on convex slopes. Some of the clinker and particularly coarse soils would be replaced as substrate for pines and junipers. Topsoil would be seeded within 90 days of the time it was placed. Disturbed areas would be stabilized during lengthy intervals between topsoiling and seeding with a temporary seeding mixture.

c. Revegetation of mined area

Following topsoil placement, ripping and deep chiseling would be done on the contour to loosen the soil for rapid water infiltration and root penetration, and to tie the topsoil to the underlying layer. The surface would be manipulated only upon recommendation by the Department of State Lands.

Unless conditions suggest doing otherwise, clean straw would be applied at a rate of 3,000 lbs/acre and anchored into the topsoil to prevent or reduce erosion. This would provide a thin, evenly spread layer of mulch, leaving only one-quarter to one-half of the bare soil exposed. Drill or broadcast seeding may either precede or follow mulching.

The seeding mixture would include native and introduced species which have demonstrated rapid establishment and development. Species proposed for the Pearl mine and the rate of seed application are given in table I-5. Drill seeding would be done on the contour; a rangeland drill specially designed to effectively seed rocky or rough terrain would be used if available. Broadcast seeding, which distributes the seed and allows it to find its own niche and planting depth, would be used only on rough cloddy seedbeds, where drill seeding is impractical. The company would transplant rhizomatous species of shrubs from surrounding areas in early spring. Ponderosa pines and junipers would be transplanted, using a tree spade, in a 9:1 ratio to north and east exposures, on slopes seeded with the "area 3" mixture.

Proper fertilizer, as determined by soil testing, would be applied after seedlings emerge in spring or immediately after seeding in fall. Fertilizer might also be intermixed with the surface soil as part of seedbed preparation.

TABLE I-5.--Proposed Pearl project seeding mixture

Species	Rate (pounds/acre[1])
Area 1 - Bottoms of swales (finer textured soils over 1 foot deep)	
*Western wheatgrass	5.0
*Thickspike wheatgrass	4.0
*Green needlegrass	4.0
*Big bluestem	2.0
*Basin wildrye	2.0
Kentucky bluegrass	2.0
*Canada bluegrass	2.0
Cicer milkvetch	0.5
Sainfoin	0.5
*#Silver sagebrush	0.1
*#Big sagebrush	0.1
*Snowberry	Sod plugs to be taken from future pit areas
*Rose	Sod plugs to be taken from future pit areas
*Native forb mixture	1.0
Total	23.2
Area 2 - Flat to concave gentle slopes adjacent to intermittent drainages	
*Western wheatgrass	5.0
*Thickspike wheatgrass	3.0
*Slender wheatgrass	3.0
*Green needlegrass	3.0
*Blue grama	1.0
*Sideoats grama	1.0
*Prairie junegrass (little bluestem as substitute)	2.0
*Needle-and-thread (sand dropseed as substitute)	2.0
*Bluebunch wheatgrass (Whitmar wheatgrass as substitute)	2.0
Cicer milkvetch	0.5
Sainfoin	0.5
*#Big sagebrush	0.1
*#Winterfat	0.1
*Native forb mixture	1.0
Total	24.2

See footnotes at end of table on p. I-31.

TABLE I-5.--Proposed Pearl project seeding mixture--Continued

Species	Rate (pounds/acre[1])
Area 3 - Convex slopes	
*Western wheatgrass	3.0
*Thickspike wheatgrass	2.0
*Slender wheatgrass	2.0
*Bluebunch wheatgrass (Whitmar as a substitute)	4.0
*Prairie junegrass (sideoats grama as a substitute)	2.0
*Needle-and-thread grass (sand dropseed as a substitute)	3.0
*Green needlegrass	2.0
*Indian ricegrass	1.0
*Blue grama	1.0
*Little bluestem	2.1
*Prairie sandreed	0.5
Cicer milkvetch	0.5
Sainfoin	0.5
*#Winterfat	0.1
*#Rubber rabbitbrush	0.1
*#Skunkbush sumac	0.1
*#Fourwing saltbush	0.1
*#Mountain mahogany	0.1
*Native forb mixture	1.0
Total	25.1
Area 4 - Temporary reclamation areas (such as overburden from cuts 1 and 2, south pit)	
*Western wheatgrass	3.0
*Thickspike wheatgrass	3.0
*Slender wheatgrass	2.0
Crested wheatgrass	3.0
Kentucky bluegrass	2.0
Smooth brome	3.0
Cicer milkvetch	0.5
Sainfoin	0.5
Hard Fescue	2.0
Wheat or barley	10.0
Total	29.0

See footnotes at end of table on p. I-31.

TABLE I-5.--Proposed Pearl project seeding mixture--Continued

Species	Rate (pounds/acre[1])
Area 5 - Roads and railroad cuts and fills	
*Western wheatgrass	3.0
*Thickspike wheatgrass	3.0
*Slender wheatgrass	2.0
Crested wheatgrass	2.0
Smooth brome	2.0
*Sideoats grama	0.5
*Little bluestem	0.5
*Canada wildrye	1.0
Cicer milkvetch	0.5
Sainfoin	0.5
*#Rubber rabbitbrush	0.1
*#Fourwing saltbush	0.1
*#Big sagebrush	0.1
*#Silver sagebrush	0.1
Total	15.4
Area 6 - Topsoil stockpiles	
*Thickspike wheatgrass	10.0
*Slender wheatgrass	8.0
Sainfoin	1.0
Cover crop mixture	12.0
Total	31.0

Species	Rate(oz.)[1]
Native forb mixture	
Prairie coneflower (_Ratibida columnifera_)	1
Purple prairie clover (_Petalostemon purpureum_)	2
Maxmillian sunflower (_Helianthus maxmiliana_)	1
Blue flax (_Linum perenne_)	2
Western yarrow (_Achillea millefolium_)	2
Cudweed sagewort (_Artemisia ludoviciana_)	2.5
Balsamroot (_Balsamorhiza sagitatta_)	2
Harebell (_Campanula rotundifolia_)	1.5
Eriogonum (_Eriogonum heraclioides_)	1.5
Gaillardia (_Gaillardia aristata_)	0.5
Total	16

[1]This rate is 90-percent pure live seed, and all rates reflect germination percentages. Genotypic seeds and seedlings from local sources will be used when available. Rates will be doubled for aerial broadcast seeding.

*Native species.

#Tublings or transplants may be used in lieu of seed, depending on availability.

d. Abandonment of the mine

After mining is completed, reclamation would continue until completed. The mined area would be completely backfilled and the surface recontoured to the approximate original contours. All haul roads would be ripped, leveled, and revegetated. The silos, powerlines, and railroad loop may be left for use by other area mines built in the future. When no longer needed, these facilities would be removed and the area reclaimed.

H. ADDITIONAL REQUIREMENTS TO MEET STATE AND FEDERAL REGULATIONS

Additional requirements to meet State and Federal regulations are discussed in chapter III of the regional part of this statement.

CHAPTER II

DESCRIPTION OF THE EXISTING ENVIRONMENT

A. GEOLOGY

1. Topography and Geomorphology

The Pearl area is characterized by open valleys bordered by gentle slopes rising to steep sandstone bluffs (fig. I-2). Relief generally increases to the west. Both lease tracts occupy topographically high positions between Youngs and Little Youngs Creeks. Maximum relief between the hilltops and the valley bottoms is about 300 feet.

Youngs Creek and Little Youngs Creek, the two perennial streams crossing the permit area, join within one-half mile south of the Montana-Wyoming border, and flow southeasterly to the Tongue River. Youngs Creek and Little Youngs Creek have formed at least two alluvial terraces, one about 3 feet higher than the present floodplain, and another about 10 feet higher than the flood plain. Parts of the high terrace along both streams are, or have been, irrigated. Youngs Creek has a distinct floodplain; that along Little Youngs Creek is not as distinct, possibly because of its lower discharge rate.

Slope runoff and high channel flows occur in response to snowmelt or intense rainstorms. Runoff from rainstorms is unpredictable. Ground-water discharge maintains a baseflow in the two perennial streams.

Erosion rates in a semiarid climate are naturally high (Langbein and Schumm, 1958). Sheet erosion processes (raindrop impact, sheet wash, and rill wash), although not as dramatic as gully or channel erosion, probably supply most of the sediment yield. Sheet erosion and sediment transport are sporadic, and occur mostly during thunderstorms (See Climate, chapter II) when raindrop impact plays an important role. Channel erosion along perennial streams is a minor contributor of sediment yield when compared to the erosion that occurs during major rainfall events. Generally, the landscape remains relatively unchanged during long periods of time, possibly years, only to undergo significant erosion during major storm events.

2. Stratigraphy, Overburden, and Interburden

Sedimentary strata exposed at the surface in the Pearl area, from oldest to youngest, include the Tongue River Member of the Fort Union Formation of Tertiary age, the Wasatch Formation of Tertiary age, and the alluvium of Holocene age.

The Tongue River Member of the Fort Union Formation consists of interbedded claystone, siltstone, sandstone, coal, and clinker (fig. II-1). In this area, the Tongue River Member contains about seven coal beds ranging from 5 to 55 feet thick (table I-2) and probably an equal number of thinner coal beds. Three of the thicker coal beds, in ascending order the

"M", "G", and "D" beds, are considered economically recoverable by strip mining methods.

The Wasatch Formation is present in the Pearl area only on some of the higher ridges and crests. It consists of interbedded claystone, sandstone, shale, and thin coal beds. The alluvium occurs along the larger stream courses and consists of unconsolidated beds of sand, gravel, and silt.

The overburden and interburden, primarily silty and sandy shales of the Tongue River Member of the Fort Union Formation, vary greatly in thickness. The overburden above the D coal seam ranges from 0 feet, where the seam outcrops, to approximately 200 feet in thickness. The interburden ranges from about 40 feet to over 300 feet between the D and G coal beds, and from 8 feet to almost 300 feet between the G and M coal beds.

The company has submitted chemical and physical analyses of samples from eight drill holes in the permit area (fig. II-2), four from each tract. The samples were collected at vertical intervals ranging from 2 to 13 feet. The shallowest samples were taken within a foot of the surface, and the deepest from beneath the M coal seam at a depth of 426 feet. Results of the analyses were compared against suspect levels established by the Montana Department of State Lands. These levels (table II-1) are intended to evaluate the suitability of the overburden material as a revegetation medium, and are not intended to predict post-mining ground-water quality.

Concentrations of boron, lead, manganese, mercury, and selenium in the overburden are below State suspect levels, and consequently are not cause for concern. The overburden in some areas contains a few strata where copper concentrations or pH may present reclamation problems, but these areas are small.

In one 2-foot stratum in test hole 7, the copper concentration exceeded the State suspect level. Most of the overburden pH values are below the State suspect level. Three drill holes (2, 7, and 8) contain calcareous strata having a pH of 8.8 (alkaline). However, several drill holes intercepted strata having pH values so low that acidity may become a problem. Drill holes 3, 4, 7, and 8 intercepted strata having pH values below 5.0. These acidic layers are commonly associated with carbonaceous material.

The overburden contains numerous strata which exceed State suspect levels for nitrates, salinity, sodium-adsorption-ratio, texture (clay content), and zinc. (See appendix B.) Strata with excessive clay content are found throughout the stratigraphic section in both tracts. The highest concentrations of nitrates and soluble salts were found in the clinker overburden in the northwest tract. Higher sodium-adsorption-ratios were found in the southern tract, particularly in drill holes 7 and 8. The higher zinc concentrations are also in the southern tract.

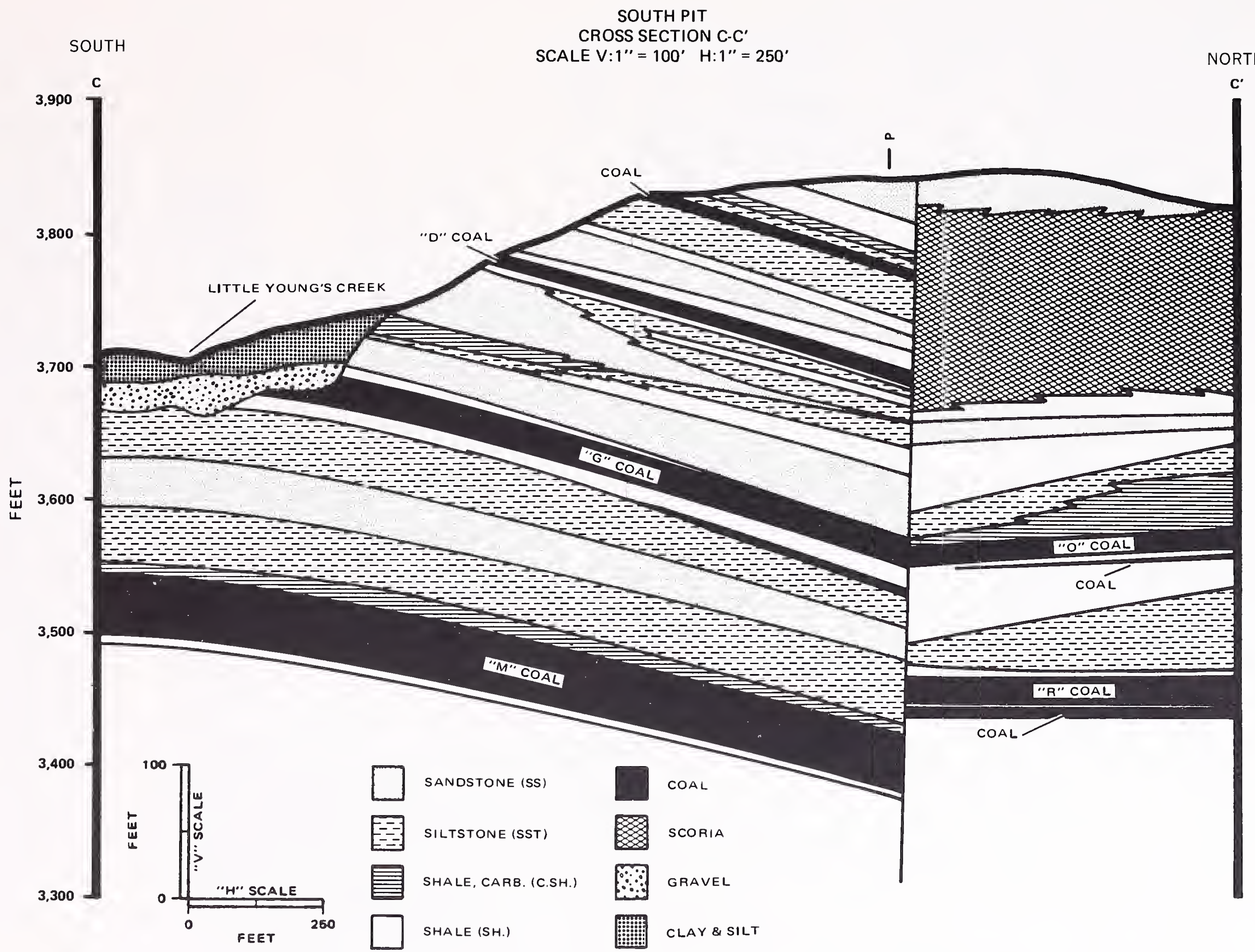
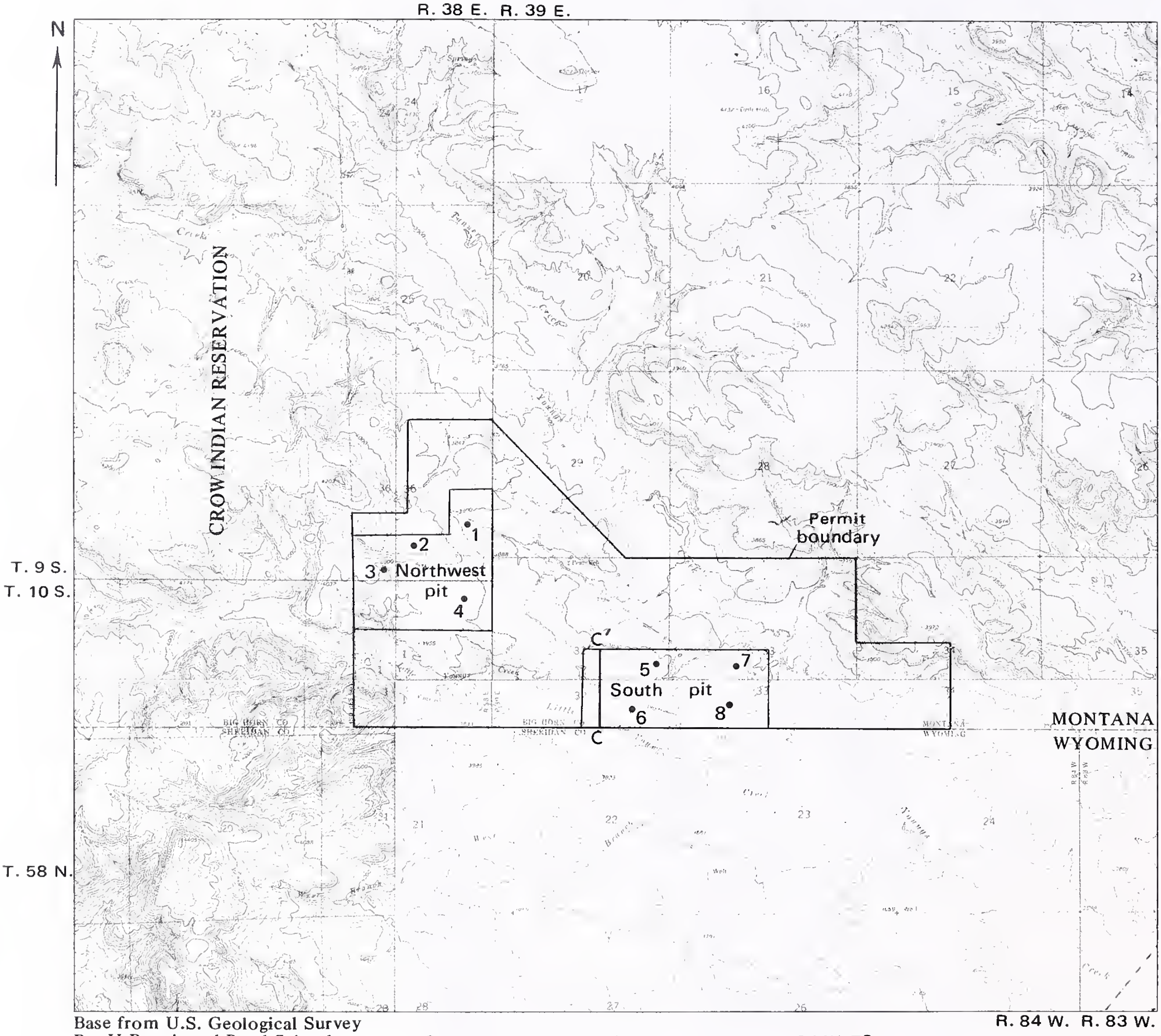


Figure II-1.–Geologic cross section of the south pit. (See fig. II-3 for map location of cross section.)



Base from U.S. Geological Survey
Bar V Ranch and Pearl School
1:24,000, 1967, Montana
Acme, 1968 and Monarch, 1964
1:24,000, Wyoming

0 1 2 MILES

Figure II-2.—Location of overburden holes. (C-C' is the location of the cross section shown in fig. II-1.)

TABLE II-1.--State suspect levels[1]

[Suspect levels are given in parts per million unless otherwise indicated]

Parameter	Suspect level
pH	8.8 - 9.0
Conductivity (salinity)	4 - 6 mmhos/cm
Sodium-adsorption-ratio	12
Texture	40% clay
Boron	8
Cadmium	0.1 - 1
Copper	40
Iron	Not defined
Lead	(pH 6 (10-15); pH 6 (15-20))
Manganese	60
Mercury	0.4 - 0.5
Molybdenum	0.3
Nickel	1.0
Selenium	2.0
Zinc	40
Ammonium - Nitrogen	Not defined
Nitrate - Nitrogen	Federal drinking water standard[2] is 10 Federal livestock standard is 45

[1]State suspect levels are guidelines, intended to determine overburden suitability for revegetation and are not indicative of potential ground-water contamination; however, water quality is closely related to solubility of overburden constituents.

[2]Water standards are used because of the high solubility of nitrates.

Most of the overburden contains concentrations of nickel, cadmium, and molybdenum in excess of the State suspect levels. (See appendix B.) The highest concentrations of both molybdenum and nickel occur in the finer textured rocks.

3. Structure

The proposed Pearl minesite is near the west-central boundary of the Powder River structural basin. The strata in the mine area generally dip about about 1 degree toward the southeast, except between faults on the mine property where the dip is as much as 9 degrees toward the northwest.

The faults generally trend northeast and are downthrown on the southeast side. Near the southern lease tract the strata are offset as much as 400 feet.

4. Minerals Other Than Coal

Abundant quantities of clinker crop out on the leasehold. Small lenses of sand and gravel occur in the alluvium of Youngs and Little Youngs Creek; they are not considered to be of significant economic value.

No other known minerals occur in commercial quantities on the leasehold.

5. Paleontology

Plant and invertebrate fossils occur in all units mapped in the region. These fossils do not appear to be significant according to the following BLM criteria: 1) They do not provide important information on the evolutionary trends among organisms. 2) They do not provide information regarding the development of biological communities or interaction between botanical and zoological biotas. 3)They do not demonstrate unusual or spectacular circumstances in the history of life. 4) They are not in short supply and are not in danger of being depleted or destroyed by the elements, vandalism, or commercial explotation, and are available in other geographic locations. Investigations on the nearby Spring Creek area (Bown and McGrew, 1976) have shown that fossils found in the area are poorly preserved and/or unidentifiable, and that similar plant and animal fossils are much better represented at other sites in equivalent rocks outside the area.

6. Petroleum and Natural Gas

Several oil and gas leases overlap the Pearl coal lease area (fig. I-6). There are no oil or gas wells in the permit area; however, a productive well in the northern part of the Ash Creek oil field is about 2 miles west. The Ash Creek and Ash Creek South oil fields produce oil from an average depth of 4,600 feet (Morgando, 1958), far below the depth to which the Pearl mine will extend.

B. HYDROLOGY

1. Surface Water

a. Runoff

Two perennial streams, Youngs Creek and Little Youngs Creek, and several of their ephemeral tributaries drain the permit area. Little Youngs Creek joins Youngs Creek just south of the Montana-Wyoming border; Youngs

Creek continues southeasterly to join the Tongue River about 16 miles upstream from the Tongue River Reservoir. Peak flows on the perennial streams occur from rapid snowmelt as well as from intense rainstorms. Peak discharges (table II-2) for several subbasins within the permit area (fig. II-3) were estimated using methods described by Johnson and Omang (1976).

TABLE II-2.--Summary of peak discharge computations

[Source: Morrison-Maierle (1977) p. 29]

Basin (fig. II-3)	Peak discharges, cfs[1] Recurrence interval, years					
	2	5	10	25	50	100
A--------	54	141	227	365	495	645
B--------	4	11	20	36	53	74
C--------	2	6	12	22	32	46
D--------	5	18	33	60	87	122
E--------	2	8	15	27	40	58
F--------	78	201	319	507	683	886
G--------	2	6	11	21	31	44
H--------	33	93	153	250	344	455
I--------	2	6	11	20	30	42
J--------	37	102	168	274	376	496
K--------	99	249	391	616	825	1,000

[1]Estimated peak discharges have associated average standard errors of 90, 80, 80, 83, 88, and 93 percent for the 2-, 5-, 10-, 25-, 50-, and 100-year estimates, respectively (Johnson and Omang, 1976). This means that two-thirds of the time the recorded 2-year peak discharge would be within ±90 percent of the estimated value.

b. Water quality

Water quality data indicate that water in both Youngs Creek and Little Youngs Creek is generally a magnesium calcium bicarbonate type. The water is low in trace metal concentrations.

The quality of Youngs Creek and Little Youngs Creek in the project area during low flow is characterized by samples collected October 27, 1977. Youngs Creek was flowing 3.7 cfs (cubic feet per second) at the time and the water was of a magnesium bicarbonate type with 1,000 mg/L (milligrams per liter) total dissolved solids. Upstream from the project

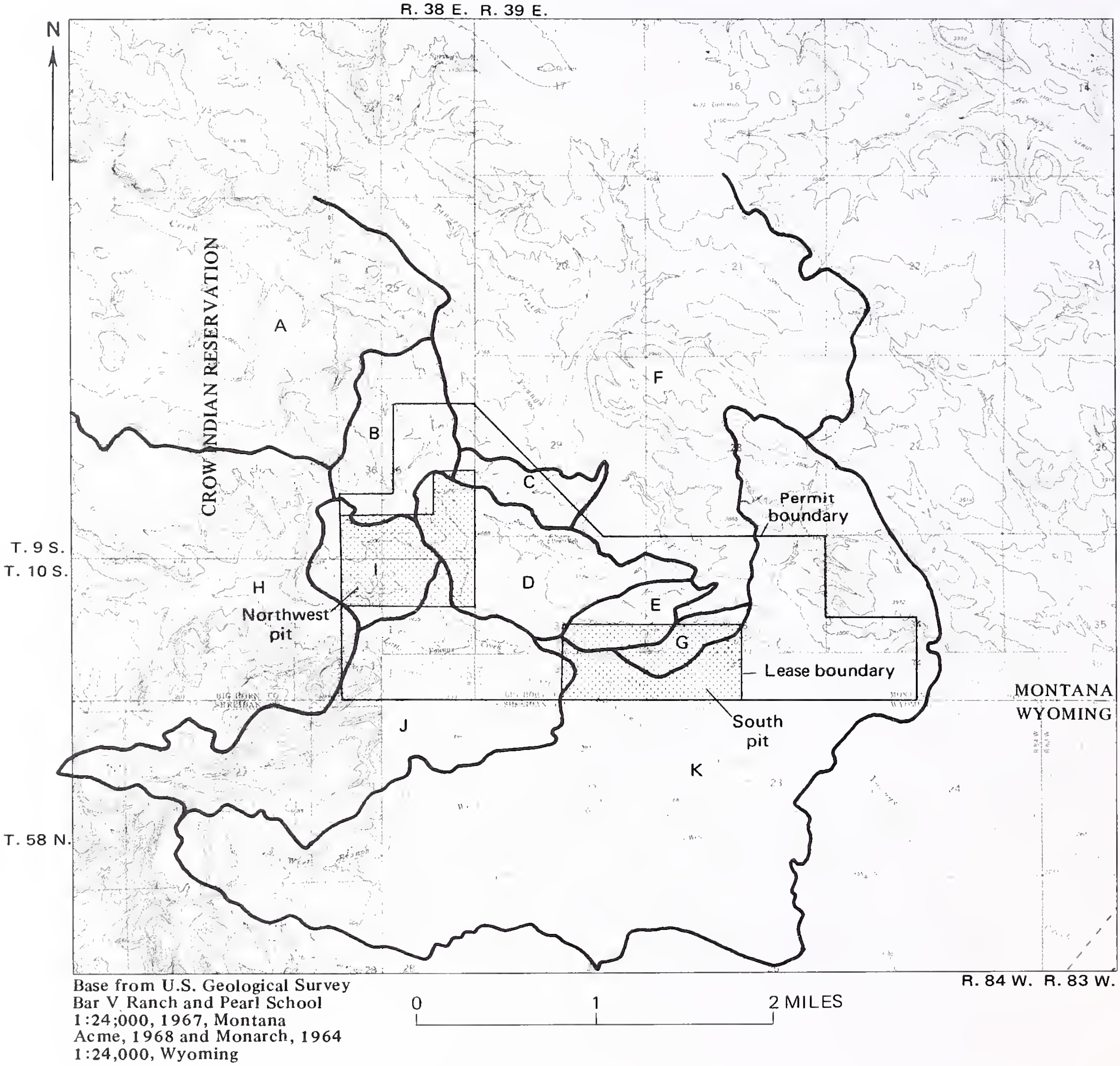


Figure II-3.—Drainage basins of the Pearl mine permit area.

area, where the flow was only 2.06 cfs, the water in Youngs Creek was a magnesium calcium bicarbonate type with only 553 mg/L total dissolved solids.

Data supplied by the company indicate that the concentration of total dissolved solids is normally below 500 mg/L. The concentration of dissolved solids is lower at times of higher flow.

The natural sediment yield, assumed to be 1 acre-foot/mi^2/year for undisturbed land in this area, varies depending upon vegetation cover, soil type, and other land characteristics. Samples collected on Youngs Creek near the proposed minesite show total suspended solids ranging from 2 to 422 mg/L. Samples collected on Little Youngs Creek west of the lease area had suspended sediment concentrations ranging from 38 to 326 mg/L. During major storm events, sediment concentrations would be considerably higher.

c. Present use

Presently, surface water on the permit area is used by livestock, wildlife, and ranchers irrigating hay meadows. There are several ponds in the vicinity of the proposed permit area; on the permit area itself, ponds are located along Little Youngs Creek (SE1/4 sec. 1, T. 10 S., R. 38 E.), and an apparently unused pond (NW1/4 sec. 32, T. 9 S., R. 39 E.) is located along an ephemeral stream which drains to Youngs Creek. A zone of springs along the north edge of Little Youngs Creek alluvium (sec. 1, T. 10 S., R. 38 E.) supplies domestic water for a nearby ranch house.

2. Ground Water

a. Aquifers

Aquifers in the permit area important to this study are: the alluvium of Youngs Creek and Little Youngs Creek; the G, M, O, and R coal seams; sandstone aquifers between the coal seams; and the clinker. Hydraulic characteristics are presented in table II-3.

The alluvial aquifers consist of sand, gravel, silt, and clay, and are 50 to 80 times more transmissive of water than the coal beds (table II-3). Although data on the Little Youngs Creek alluvium are not available, its characteristics are assumed to be similar to that of Youngs Creek. These aquifers are recharged directly by precipitation, infiltration from streams and from flood irrigation, and seepage from bedrock aquifers. Discharge may be by return flow to the streams, by phreatophytic (water loving) vegetation, and by downward or lateral leakage to other aquifers. Seepage runs conducted along Youngs Creek and Little Youngs Creek just west of the proposed permit area during September 1972 indicate that surface water flow along both streams is fed by the alluvial aquifer. Additional studies will be conducted in the permit area beginning in the spring of 1979. The valleys of Little Youngs Creek and Youngs Creek

TABLE II-3.--Summary of aquifer hydraulic tests

Geologic unit tested	Number of tests reported	Transmissivity (ft^2/day) Maximum	Minimum	Average
M coal and clinker---------	1	3,300	3,300.0	3,300
M coal------------	10	180	0.6	51
G coal------------	4	80	3.3	30
G and M coal------	2	30	17.0	25
O coal------------	2	49	5.4	27
Alluvium----------	6	4,800	1,300.0	2,500

were mapped as an alluvial valley floor by Malde and Boyles (1976). The determination has not yet been made by the regulatory authorities as to whether these constitute alluvial valley floors within the meaning of SMCRA.

An unused domestic well (along the south edge of the south pit) obtains water from the alluvium along Little Youngs Creek; several other wells obtain water from the alluvium of Youngs Creek.

Coal aquifers underlie the entire permit area. The G and M coal aquifers probably are recharged locally at clinker and coal outcrops, and by vertical infiltration where the overlying strata are thin. The water in these aquifers moves laterally to the northeast even though the regional dip of the strata is to the southeast (fig. II-4).

Coal is not as permeable as the alluvium or clinker. Estimates based on the average value of transmissivity of the M coal and a single value for the G coal, indicate that the discharge to the northeast in these coals would be about 50 gpm (gallons/minute) through the 3-mile width between the bounding faults that control the flow. Due to the uncertainty of the effective transmissivity of the coal aquifers, this figure represents only the general order of magnitude of the flow.

No data are available for recharge or discharge of the O or R coal seams. Information available on the O coal seam indicates that its hydrologic characteristics are similar to those of the G and M coal seams.

Bedrock wells in the area, which yield adequate supplies of water for livestock and domestic use, are commonly completed in the G, M, and O coal seams.

Outcropping coal seams (G and M) along Little Youngs Creek have burned, forming clinker. Clinker is present in the southern part of the northwest tract, and northwest of the fault in the southern tract where it may be in contact with the alluvial aquifer. Test data indicate that the clinker is very permeable; however, it appears to be unsaturated in

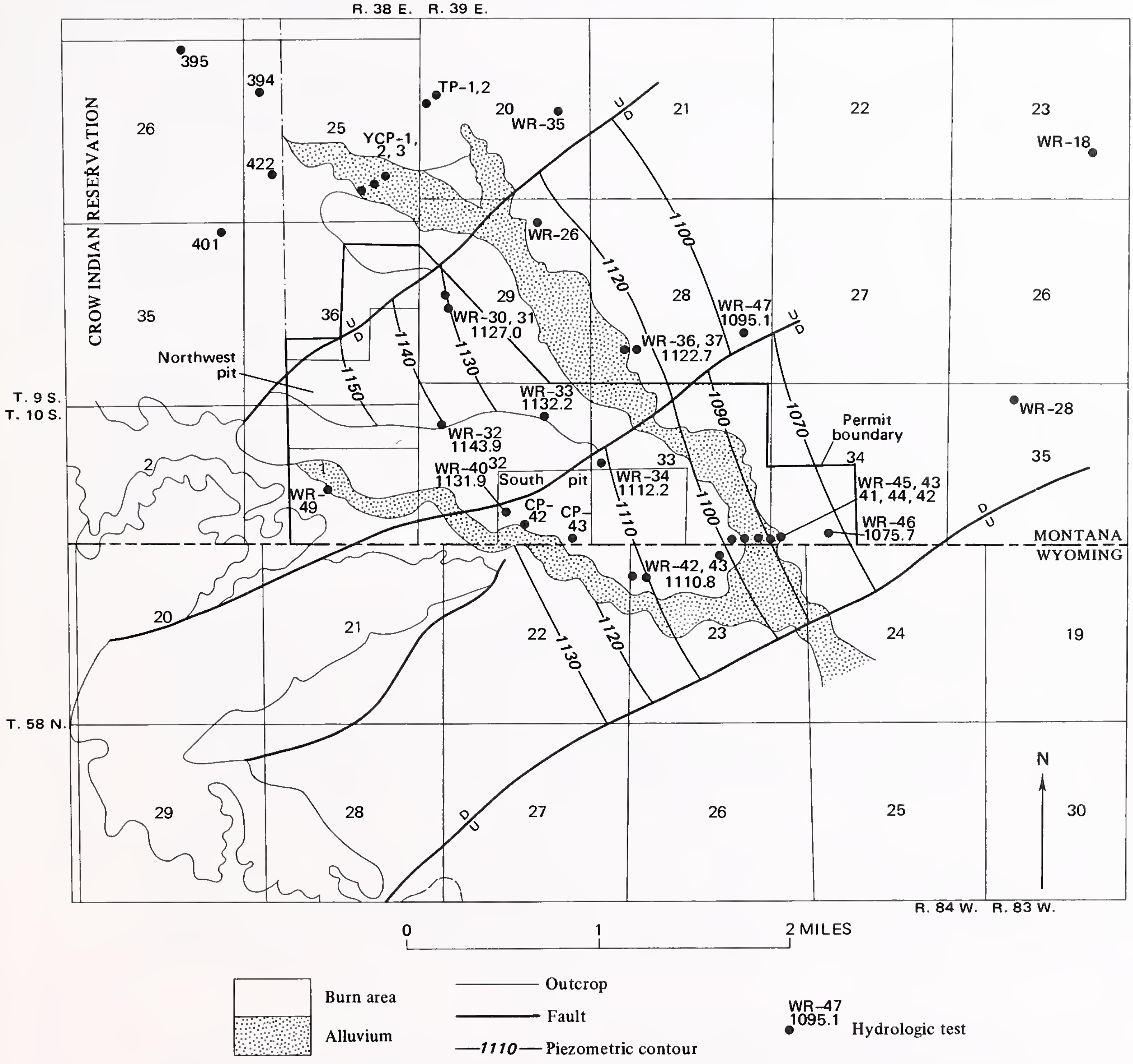


Figure II-4.—Hydrologic characteristics of the Pearl area.

the permit area. It has not been determined if the water from the clinker or the alluvium supplies the springs along Little Youngs Creek.

Several sandstone beds between the coal beds are aquifers, but no data are available on their hydraulic characteristics or water quality. One well in section 29 produces from a thick sandstone bed between the O and R coal beds.

b. Movement

In the lease area, ground-water movement in the G and M coal aquifers is controlled by a series of northeast-trending faults which prevent the general down-valley flow as in the area northwest of the minesite. On the minesite, ground water in the G and M coal moves to the northeast between faults toward the Tongue River Reservoir in the vicinity of the Decker mine. No data are available on ground-water movement in the O and R coal seams, and the various sandstone aquifers, but they are presumably the same as in the G and M seams. Movement in the alluvial aquifers is southeastward along the valleys of Youngs and Little Youngs Creeks.

c. Water quality

Ground-water-quality data are not available for the actual minesite. However, limited data are available upstream from the permit area (appendix C). A report by Hedges and others (1976) shows that water samples from alluvium along Tanner Creek (which joins Youngs Creek upstream from the minesite) were a magnesium sulfate type containing total dissolved solids concentrations of less than 1,900 mg/L. Samples submitted by the company from alluvium along Youngs Creek indicated a magnesium sulfate water containing 1,500 to 2,300 mg/L of total dissolved solids. Except for lead, all trace element concentrations were below Federal standards for human consumption established under 40 C.F.R. 141.11. In two samples, lead concentrations in waters from alluvium along Tanner Creek equalled or slightly exceeded the recommended limit of 0.05 mg/L. Lead concentrations in the water from the Youngs Creek alluvium equalled the recommended limit.

Hedges and others (1976) found that waters in the coal bed aquifers in the area immediately to the northwest of the permit area are predominantly a sodium bicarbonate type. Total dissolved solids concentrations in these aquifers ranged from 400 to 2,800 mg/L, with concentrations between 1,000 mg/L and 2,000 mg/L most common. The pH of the coal seam waters ranged from 7.5 to 9.5. The sodium-adsorption-ratio for most samples was greater than 20. Such water may be suitable for domestic or stock use, but it is too high in sodium for irrigation.

C. CLIMATE

The temperature and precipitation patterns at the Pearl leasehold are typical of a semiarid climate. The area is characterized by cold

winters, windy, wet springs, warm summers, abundant sunshine, moderate relative humidity, and low but highly variable precipitation.

1. Precipitation

Precipitation is the limiting factor for most biological and physical processes in the Pearl area. (See Vegetation, Wildlife, and Soils, chapter II.) Mean annual precipitation at the Decker weather station, about 4 miles east of the permit area, is 12.2 inches (average from 1950-76). This amount, reflecting the rainshadow effect of the Big Horn and Wolf Mountains to the west, is about 3 inches lower than the mean annual regional precipitation.

Precipitation peaks in the spring and fall, with spring rainstorms comprising 40 percent of the total annual precipitation and fall rainstorms comprising somewhat less than this. Most of the spring precipitation occurs as thunderstorms of between 0.5 and 0.75 inches per 24-hour period. Short-duration high-intensity precipitation events are not uncommon, with at least a 1-inch storm during a 6-hour period occurring on an average once every 2 years (table II-4).

TABLE II-4.--Recurrence intervals of 6- and 24-hour precipitation events at the Pearl leasehold[1]

Recurrence interval (years)	Pearl 6-hr storm (inches)	Pearl 24-hr storm (inches)	Decker 24-hr storm (inches)
2	1.0	1.4	1.2
5	1.4	1.9	1.7
10	1.6	2.4	2.2
25	1.9	2.8	2.8
50	2.1	3.0	3.4
100	2.4	3.4	4.0

[1]U.S. Department of Commerce, 1973, Precipitation-frequency atlas of the Western United States: National Oceanic and Atmospheric Administration, Atlas 2, v. 1, Montana.

Precipitation effectiveness, a measure of net precipitation less potential evaporation, indicates that July and August are the driest months during the growing season (fig. II-5). Similarly, July and August are characterized by the lowest mean relative humidity (47 percent; mean annual is about 59 percent, fig. II-5) and highest mean insolation (0.42 and o.32 Langleys/hour; mean annual is 0.26 Langleys/hour). The total annual precipitation effectiveness, the P-E index, is 17.4 inches, indicative of of a semiarid climate (Thornthwaite, 1931).

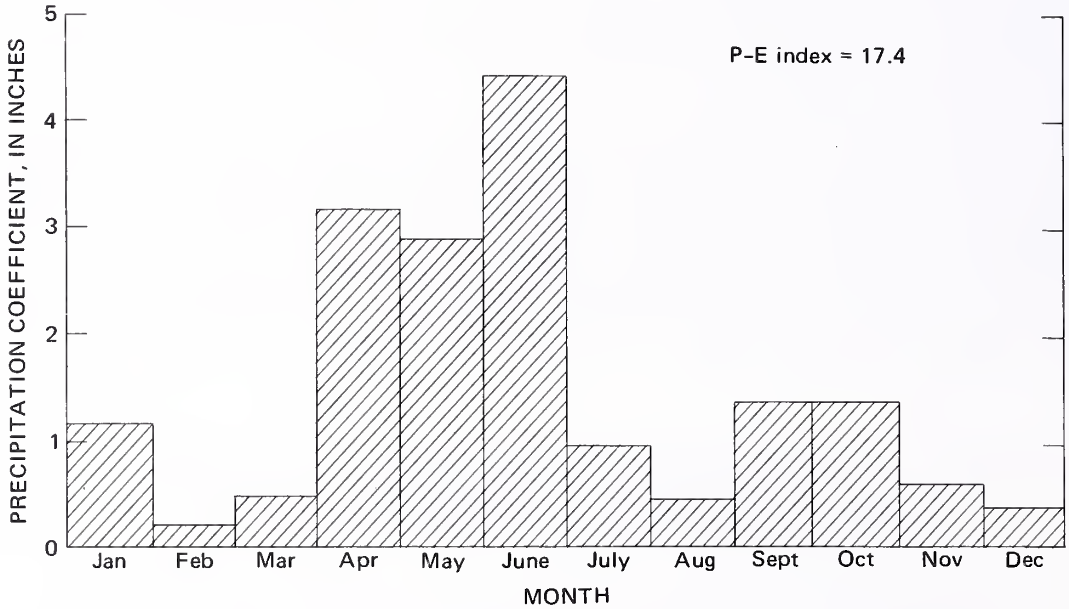


Figure II-5.—Monthly precipitation effectiveness at the Shell Pearl leasehold. The annual precipitation effectiveness index (P-E index) is 17.4, denoting a semiarid climate.

2. Temperature

Mean monthly temperature (fig. II-6) at the leasehold ranges from 25°F in January to 68°F in July. Mean maximum temperatures around 96°F occur in July and mean minimum temperatures around -20°F occur in December (fig. II-6). Due to elevational differences, the average frost-free season may be slightly shorter than the 90 to 110 days at Decker (U.S.D.A., 1972). However, during both 1976 and 1977, the frost-free season near the leasehold was 153 days.

3. Wind, Stability, and Visibility

Mean seasonal and annual wind direction is from the west through the west-northwest, approximating the principal stream direction in the area (fig. II-7). During the warmer months, the frequency of easterly winds increases (fig. II-7). Monthly wind speeds differed significantly between sample periods (1976-77), but generally are highest during spring and summer. Mean annual wind speed is 6.5 mi/hr.

Atmospheric stability tends to be neutral to unstable, suggesting favorable dispersal of air pollutants and suspended particles (table II-5). Summer has the greatest vertical diffusion with slightly unstable to extremely unstable conditions prevailing 56 percent of the time (table II-5). During winter and early spring months the atmosphere is neutral to stable. Westerly winds may persist several days at a time, usually during periods of neutral atmospheric conditions. This indicates that considerable surface airflow across the permit area may adjoin airsheds from other proposed and existing strip mines in the Decker area.

Visibility averages about 30 miles and is rarely less than 20 miles (table II-6). The sky is usually either completely clear or cloudy at the minesite, with partly cloudy days occurring about 19 percent of the year (table II-6).

TABLE II-5.--Atmospheric stability class frequency distribution during the sample period 1976-77 at Pearl

	Frequency of occurrence (percentage)									
Season--------	Winter		Spring		Summer		Autumn		Annual	
Sample period-	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Stability classes:										
Extremely unstable--	11.2	12.0	10.5	11.5	16.3	15.6	8.7	12.7	11.7	14.8
Unstable---	12.0	12.7	10.4	12.0	16.4	15.3	15.8	14.0	13.8	13.3
Slightly unstable--	17.7	16.3	23.4	23.1	22.9	26.4	26.1	26.4	22.9	23.7
Neutral----	38.1	38.7	38.3	38.8	32.8	30.9	34.7	35.4	35.7	35.3
Stable-----	20.7	18.8	17.0	13.9	11.5	10.3	14.2	9.4	15.6	11.1
Extremely stable----	0.2	0.1	0.4	0.2	0.2	0.2	0.5	0.2	0.3	0.2
Very, very stable----	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0

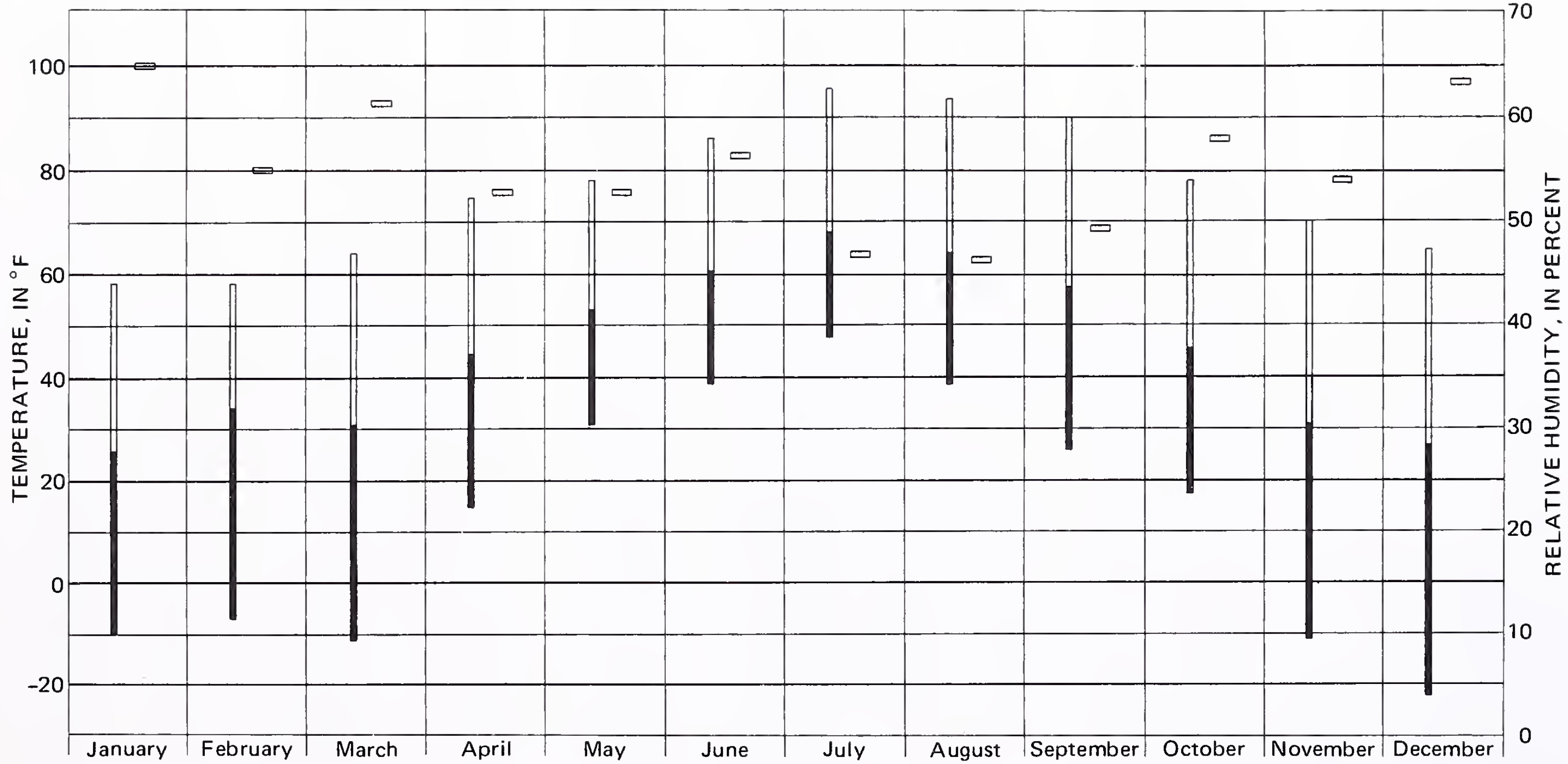
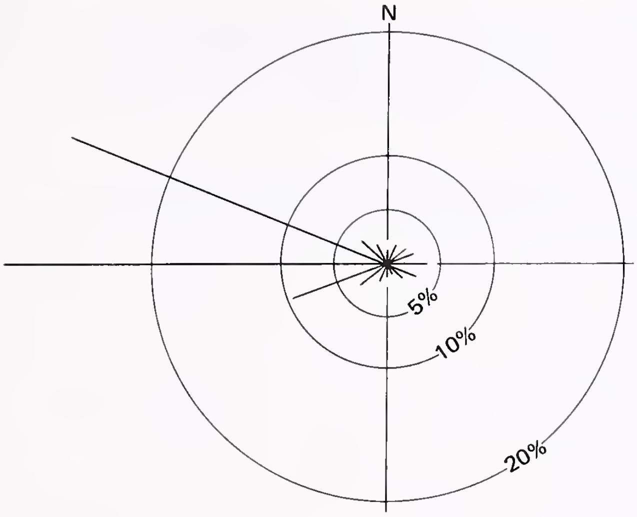
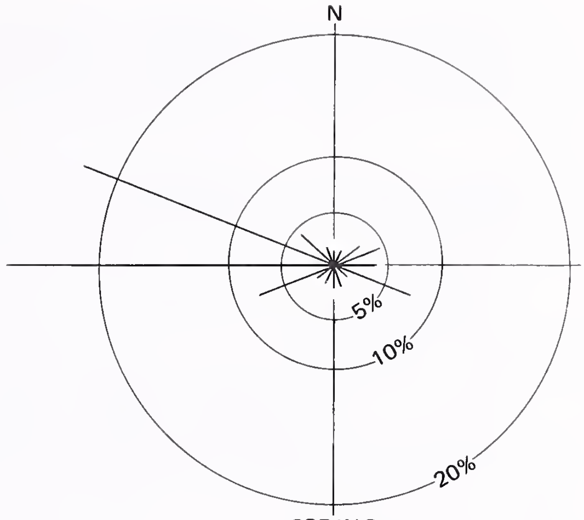


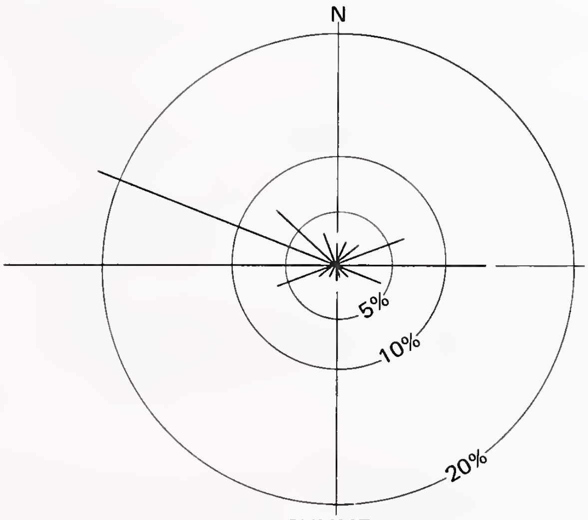
Figure II-6.–Monthly minimum, mean, and maximum temperature (vertical bars), and mean relative humidity (horizontal rectangles). (Northern Testing Laboratories, Inc., 1978).



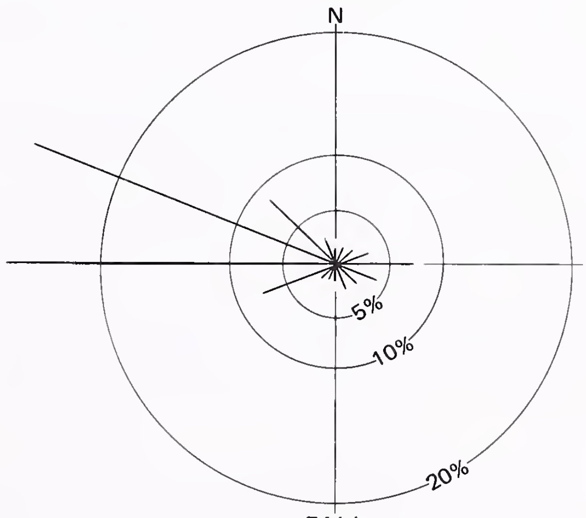
WINTER
Mean wind speed: 5.8
Percent calm: 1.5



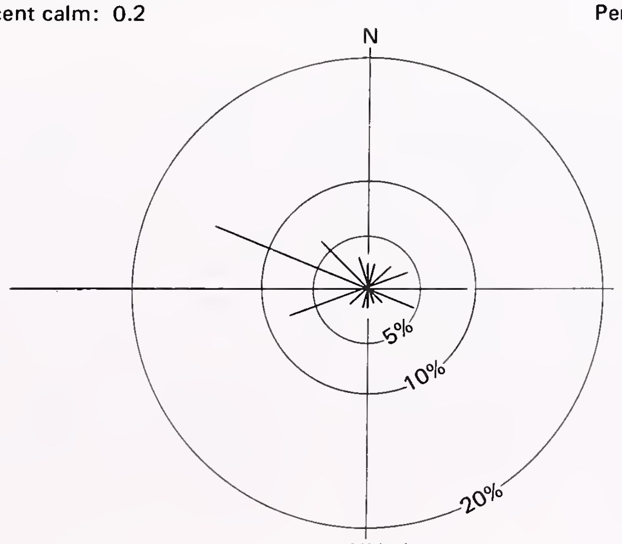
SPRING
Mean wind speed: 7.3
Percent calm: 0.0



SUMMER
Mean wind speed: 6.4
Percent calm: 0.2



FALL
Mean wind speed: 5.7
Percent calm: 1.2



ANNUAL
Mean wind speed: 6.5
Percent calm: 0.8

Figure II-7.—Mean seasonal and annual wind roses for the period 1975–77. Mean wind speed is expressed as miles per hour, and the percent of the time that there is no wind is from 1977 data.

TABLE II-6.--Frequency of visibility and cloud cover at Pearl

[Source: Northern Testing Laboratories, Inc., 1978. Data are in percent]

	10/75-9/76	10/76-9/77
Visibility:		
Less than or equal to 5 miles-------	7	7
Greater than 20 miles---------------	86	90
Cloud cover:		
0 - 29 percent cover--------------	46	41
30 - 79 percent cover--------------	17	21
80 - 100 percent cover--------------	36	38

D. AIR QUALITY

The Pearl minesite has the pristine air common to undisturbed regions. Measured concentrations of total suspended particulates (TSP) and settled particulates (dustfall) are well below Federal standards and Montana State guidelines. Gaseous pollutant concentrations and visibility characteristics similarly reflect clean air. Detectable impacts from existing mining operations occur only rarely. The designation of the Pearl mine area as Class II airshed prevents significant deterioration of air quality, thus putting constraints on permissable emissions. The Class II standard allows increased pollutant emissions up to a specified maximum. (See Regional, chapter III.) There are no correlations between TSP concentrations, dustfall amounts, precipitation, and wind speed based on monthly averages for this site.

The air-monitoring station (referred to as the CIRL [Crow Indian Reservation Lease] site), used to characterize the air quality at Pearl, is located near Youngs Creek approximately 3 miles northwest of the permit area.

The geometric mean for TSP[1] for the period January 1976 to December 1977 was 11.3 $\mu g/m^3$ (micrograms per cubic meter). This is well below the Federal secondary standard (60 $\mu g/m^3$) and the Montana State guideline (75 $\mu g/m^3$). The maximum 24-hour concentration of 163.3 $\mu g/m^3$ was recorded on May 1, 1977. Winds during that day blew continuously from the east for 18 hours at an average speed of 13.4 mi/hr. Therefore, this high concentration may have been caused in part by existing mining operations at Decker, 11 miles due east of the CIRL air monitor. This TSP concentration does not exceed the Montana State guideline of 200 $\mu g/m^3$, but it does exceed the Federal secondary standard (150 $\mu g/m^3$). Since the Federal standard can legally be exceeded once a year, this one-time concentration would not be considered a violation.

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[1]On the basis of 24-hour average concentrations measured every sixth day.

The baseline particle-size distribution of TSP reveals that the greatest percentage of particles are in the submicrometer range (table II-7). A maximum of 29.4 percent (3.2 $\mu g/m^3$) of the measured particulate is within the human respirable range (Northern Testing Laboratories, Inc., 1978).

Dustfall concentrations, measured from October 1975 to December 1977, ranged from 0.58 tons/mi^2/month to 14.22 tons/mi^2/month and averaged 6.47 tons/mi^2/month (the Montana guideline for a residential area is 15 tons/mi^2/month).

Analyses indicate that concentrations of trace elements in suspended particulates are very low (appendix D).

Concentrations of gaseous pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO) at the Pearl site are unknown. Since there are no sources emitting these gases in the area, all concentrations at the Pearl site are assumed to be within Federal standards and Montana guidelines.

TABLE II-7.--Background particle-size distribution collected from the Shell CIRL air monitoring station (Oct. 1975-Dec. 1976)

[Source: Youngs Creek, Northern Testing Laboratories, 1978. Figures shown here expressed as a percentage of the total particulate weight in a cascade impactor. Data are in percent. The reported concentrations below the minimum detectable level were calculated as one-half the minimum detectable level]

Particle size[1] class	Percentage of total particulate weight	Particle size[1] class	Percentage of total particulate weight
1-------------	6.6	4-------------	6.6
2-------------	8.4	5-------------	7.6
3-------------	6.2	6-------------	67.0

[1]Description of particle size classes:

Class 1 - 7.2 micrometers and greater. Large particles which are not likely to travel great distances and are not within the respirable fraction for humans (about 0.5 to 5.0 micrometers).

Class 2 - 3.0 to 7.0 micrometers. Intermediate sized particles, some of which may travel significant distances from the source and which are within the respirable fraction for humans.

Class 3 - 1.5 to 3.0 micrometers. Description similar to Class 2.

Class 4 - 0.95 to 1.5 micrometers. Description similar to Class 2 except that particles in this size range may form what is known as aerosols (0.2 to 2.0 micrometers). Aerosols may decrease solar radiation to the ground (McCormick and Ludwig, 1967).

Class 5 - 0.49 to 0.95 micrometers. Bottom of the respirable fraction for humans.

Class 6 - Less than 0.45 micrometers. Likely to travel up to 100-1,000 kilometers from the source, suspended for indefinite periods of time (Ames Laboratory, 1977).

E. SOILS

Soils within the Pearl permit area (fig. II-8) are fairly typical of the northern Powder River basin 10 to 14-inch precipitation zone. Table II-8 shows the soil series, taxonomic classification, area to be disturbed, and estimates of the salvageable topsoil resources. A principal characteristic of the soils, which would adversely affect reclamation, is the relatively high amount of clay and the high volume of soil dominated by smectites (montmorillonite). Smectite clays shrink and swell with variations in seasonal precipitation, reducing infiltration, increasing resistance to root penetration, and promoting erosion.

Eight hundred seventy-eight acres of soils to be disturbed are suitable,[2] only with severe or very severe limitations, for field crops (capability groups IIIe and IVe). As a result, all soils have been used been used for grazing. Capability groupings, showing agricultural potential (appendix E), are shown for each mapping unit in the permit area in table II-9. Little if any of this area has been farmed for cash crops in the past, although 50 to 100 acres has been used for hay production. (See Vegetation, Land Use, chapter II.)

Characteristics of range sites, dependent on soil texture, depth, slope, precipitation, and potential (climax) vegetation quantity and quality, are summarized for the Pearl area below:

Sites	Sandy	Silty	Clayey	Pan spots	Shallow
Acreage------------	3.49	409.19	495.52	24.56	225.10
Range of potential productivity*----	800-2,300	600-1,800	600-1,800	600-1,200	600-1,200

*In pounds of above-ground vegetation per acre.

The weighted mean maximum potential productivity is 1,624 pounds per acre. The minimum potential productivity values represent the anticipated production in a dry year for range in excellent condition. Actual production in the Pearl area has been measured at an average of 1,380 lbs/acre. Range condition, based on a comparison of actual versus potential species composition, is generally poor to fair, indicating relatively low forage value.

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[2]The Soil Conservation Service (SCS) has developed several systems for assessing the agricultural potential of a given area which include capability groupings and range site and condition classification. The above discussion is drawn largely from the "Soil Survey of the Big Horn County Area, Montana" (SCS, 1977). Capability groupings give an indication of a soil's suitability for a given agricultural use, and the limitations which should be considered.

TABLE II-8.--Soils classification and "topsoil" resource

Soil series	Taxonomic class	Area to be disturbed (acres)	Salvage depth (inches)	Salvage volume (acre-feet)
Alice sandy loam-	Coarse-loamy, mixed, mesic Aridic Haplustolls.	3.49	60	17.45
Chugter loam-----	Fine-loamy, mixed, mesic Aridic Haplustolls.	54.89	84	384.23
Cushman loam-----	Fine-loamy, mixed, mesic Ustollic Haplargids.	23.78	38	75.30
Haverson loam----	Fine-loamy, mixed (calc[1]), mesic Ustic Torrifluvents.	7.88	84	55.16
Heldt silty clay loam.	Fine, montmorillonitic, mesic Ustertic Camborthids.	67.93	30	169.83
Korchea silt loam.	Fine-loamy, mixed (calc), frigid Typic Ustifluvents.	16.81	84	117.67
Lohmiller silty clay loam.	Fine, montmorillonitic (calc), mesic Ustic Torrifluvents.	5.80	20	9.67
McRae loam-------	Fine-loamy, mixed, mesic Ustollic Camborthids.	29.67	24	59.34
Midway silty clay loam.	Clayey, montmorillonitic (calc), mesic, shallow Ustic Torriorthents.	280.91	0	0
Renohill silty clay loam.	Fine, montmorillonitic, mesic Ustollic Haplargids.	30.43	22	55.79
Spearman loam----	Fine-loamy, mixed, mesic Aridic Haplustolls.	55.92	24	111.84
Thedalund loam---	Fine-loamy, mixed (calc), mesic Ustic Torriorthents.	228.12	34	646.34
Thurlow silty clay loam.	Fine, montmorillonitic, mesic Ustollic Haplargids.	102.57	84	717.99
Travessilla loam-	Loamy, mixed (calc), mesic, lithic Ustic Torriorthents.	119.64	0	0
Wibaux gravelly loam.	Loamy-skeletal over fragmental mixed, nonacidic, mesic Ustic Torriorthents.	105.46	0	0
Winnett silt loam.	Fine, montmorillonitic, mesic Ustollic Natrargids.	24.56	0	0
Rock outcrop-----	--------------------------	59.07	0	0
	Total--	1,216.9		2,420.6

[1]Calc = Calcareous.

	Mapping unit name and number
12B	Haverson loam, 1-4% slopes
13B	Lohmiller silty clay loam, 2-4% slopes
23B	Thurlow silty clay loam, 1-4% slopes
25C	Heldt silty clay loam, 4-10% slopes
34D	Midway silty clay loam, 8-15% slopes
35C	Renohill silty clay loam, 2-8% slopes
37C	Cushman loam, 2-8% slopes
47C	Chugter loam, 2-8% slopes
334D	Midway Thedalund complex, 8-15% slopes
334E	Midway Thedalund complex, 15-35% slopes
347C	Spearman loam, 4-8% slopes
362D	Wibaux Spearman complex, 8-15% slopes
421C	McRae loam, 2-10% slopes
436D	Travesilla-Thedalund loams, 2-15% slopes
462D	Spearman Wibaux complex, 4-15% slopes
502A	Korchea soils (water table), 1-4% slopes
609C	Winnet loam, 2-8% slopes
636C	Thedalund loam, 2-8% slopes
736D	Thedalund Wibaux complex, 8-15% slopes
736E	Thedalund Wibaux stony loams, 15-65% slopes[1]
738C	Alice sandy loam, 4-10% slopes

[1] Complex includes 5 percent McRae loam.

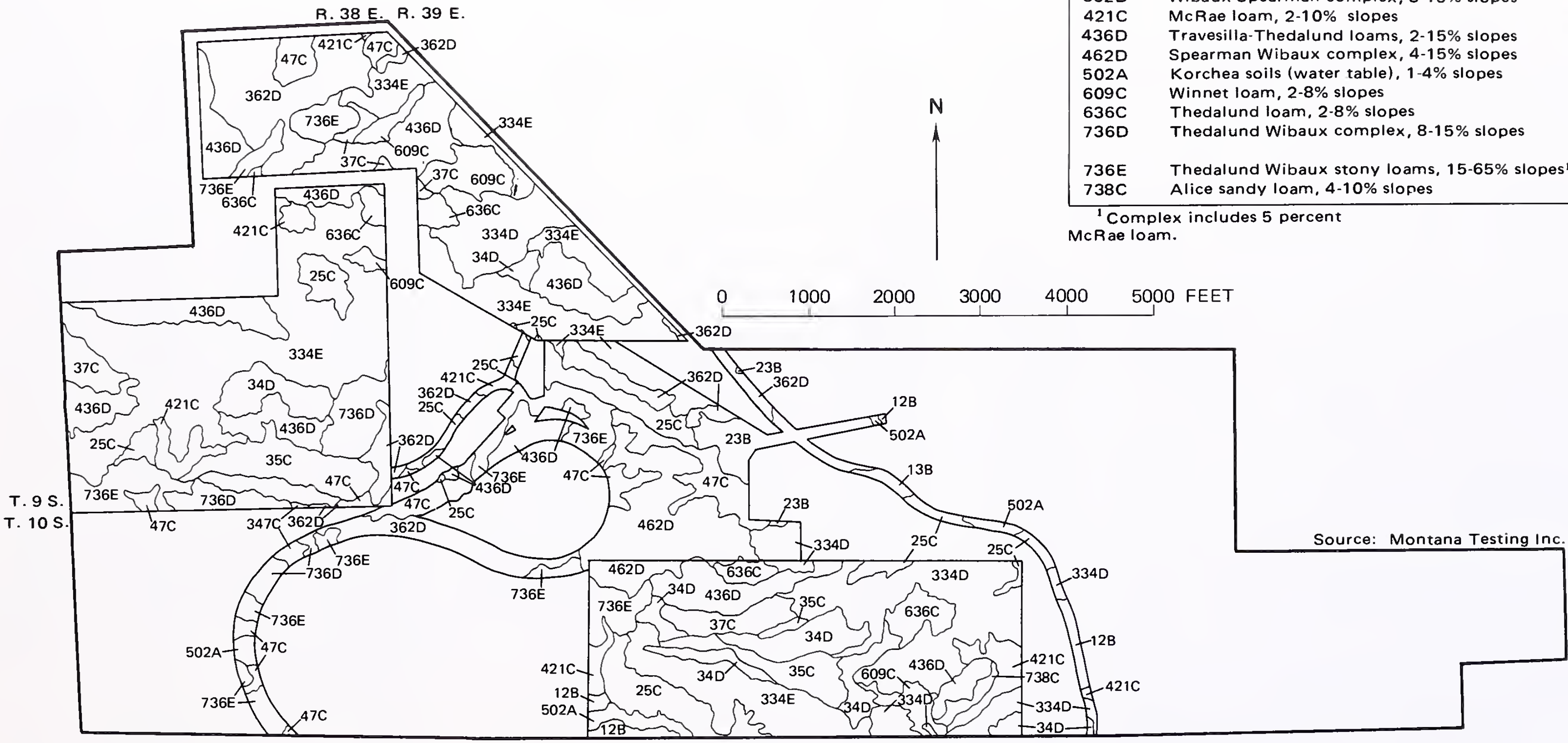

Figure II-8.—Soils map.

TABLE II-9.--Mapping unit use and salvage characteristics

Mapping unit (MU)	MU no.	Slope (percent)	Capability group[1]	MU area (acres)	Salvageable portion (percent)	Salvage volume (acre-feet)	Approximate salvage texture	Salvage limitation[2]
Haverson loam------	12B	1-4	III e	[3]7.88	100	55.16	Clay loam--	0
Lohmiller loam-----	13B	2-4	III e	[3]5.80	100	9.67	Clay-------	1
Thurlow silty clay loam--------	23B	1-4	III e	[3]102.57	100	717.99	Clay loam--	0
Heldt silty clay loam--------	25C	4-10	III e	[3]67.93	100	169.83	Clay loam--	1
Renohill silty clay loam--------	35C	2-8	III e	30.43	100	55.78	Clay-------	1
Cushman loam-------	37C	2-8	III e	23.78	100	75.15	Loam-------	2
Chugter loam-------	47C	2-8	III e	[3]53.92	100	377.44	Loam-------	0
Spearman loam------	347C	4-8	III e	1.86	100	3.72	Loam-------	2
McRae loam---------	421C	2-10	III e	[3]29.67	100	59.34	Loam-------	1
Thedalund loam-----	636C	2-8	III e	22.42	100	63.52	Clay loam--	2
Alice sandy loam---	738C	4-10	III e	[3]3.49	100	17.45	Sandy loam-	2
		Subtotal--------		349.75	---	1,605.1	-----------	
Midway silty clay loam--------	34D	8-15	IV e	53.69	0	0	-----------	3
Midway-Thedalund---	334D	8-15	IV e	141.96	30	120.67	Clay loam--	3
Midway-Thedalund---	334E	15-35	IV e	284.07	25	201.22	Clay loam--	3
Spearman-Wibaux----	462D	4-15	IV e	48.69	60	66.54	Loam-------	3
		Subtotal--------		528.41	---	388.4	-----------	
Wibaux-Spearman----	362D	8-15	VI e	86.46	40	69.16	Loam-------	3
Travissilla Thedalund--------	436D	2-15	VI e	125.67	35	124.62	Clay loam--	3
Winnett silt loam--	609C	2-8	VI e	24.56	0	0	-----------	3
Thedalund-Wibaux---	736D	8-15	VI e	19.48	50	31.66	Clay loam--	3
Thedalund-Wibaux---	736E	15-65	VI e	65.79	45	83.88	Clay loam--	3
		Subtotal--------		321.96	---	309.3	-----------	
Korchea silt loam--	502A	1-4	VI w	[3]16.81	100	117.67	Loam-------	4
		Total--------		1,216.9	---	2,420.5		

[1] Capability groups are defined in appendix E.

[2] 0 = none; 1 = salts; 2 = bedrock; 3 = shallow, rock fragments; 4 = high water table, salts.

[3] Soils derived from alluvial materials.

The soils resource may also be evaluated in terms of potential "topsoil" salvage for reclamation purposes. Within the development area, the soil salvage depth (table II-8) averages 23.9 inches (vol. ÷ acres). Average topsoil depth on the postmining surface apparently would be significantly less than 23.9 inches because alluvial soils taken from Little Youngs Creek valley would be replaced in their entirety. The actual topsoil resource available for reclamation cannot be accurately calculated from the information provided. The probable depth would be approximately 20 inches. A strong correlation between capability group and potential for salvage is evident in table II-9. The data show which series in an association is most productive and salvageable. For example, Thedalund loam is in capability group IIIe when mapped alone, in group IVe when mapped in association with Midway silty clay loam, and in group VIe when mapped with Wibaux gravelly loam. In each case, the Thedalund soils alone are salvageable, but in associations are less salvageable, especially on the steeper slopes. No group III soils exceed 10-percent slope; all are fully salvageable.

As a resource, the soils derived from alluvium are most valuable. Although they constitute only 16 percent of the proposed development area, alluvium soils constitute 53 percent of the salvageable "topsoil" and 56 percent of the group III soils.

"Topsoil" quality is fairly high. The texture averages 35 to 40 percent clays--somewhat heavier (more clayey) than would be anticipated from the SCS description. Laboratory analyses of two Thedalund loam profiles show a clay loam texture. Sixty-one percent of the "topsoil" materials is clay loam or clay.

Chemically, the "topsoil" is of generally acceptable quality. One major exception, the Winnett silt loam, is sporadically high in soluble salts and sodium, which inhibit plant growth and soil development. The Winnett soils would not be salvaged.

F. VEGETATION

Vegetation in the Pearl mine area is representative of that in the breaklands and stream courses throughout much of southeastern Montana. Species composition (appendix F) typifies the western extension of the northern Great Plains region, although similar species are also found in the Palouse Prairie and Great Basin regions. The occurrence and distribution of the flora reflect regional and local geologic and topographic features and the resulting soil, climatic, and microclimatic conditions. Grazing, fire, and cultivation of the land have also influenced plant distribution.

The vegetation types were determined by dominant species and growth form of plant communities within the permit area (Culwell, 1976). The

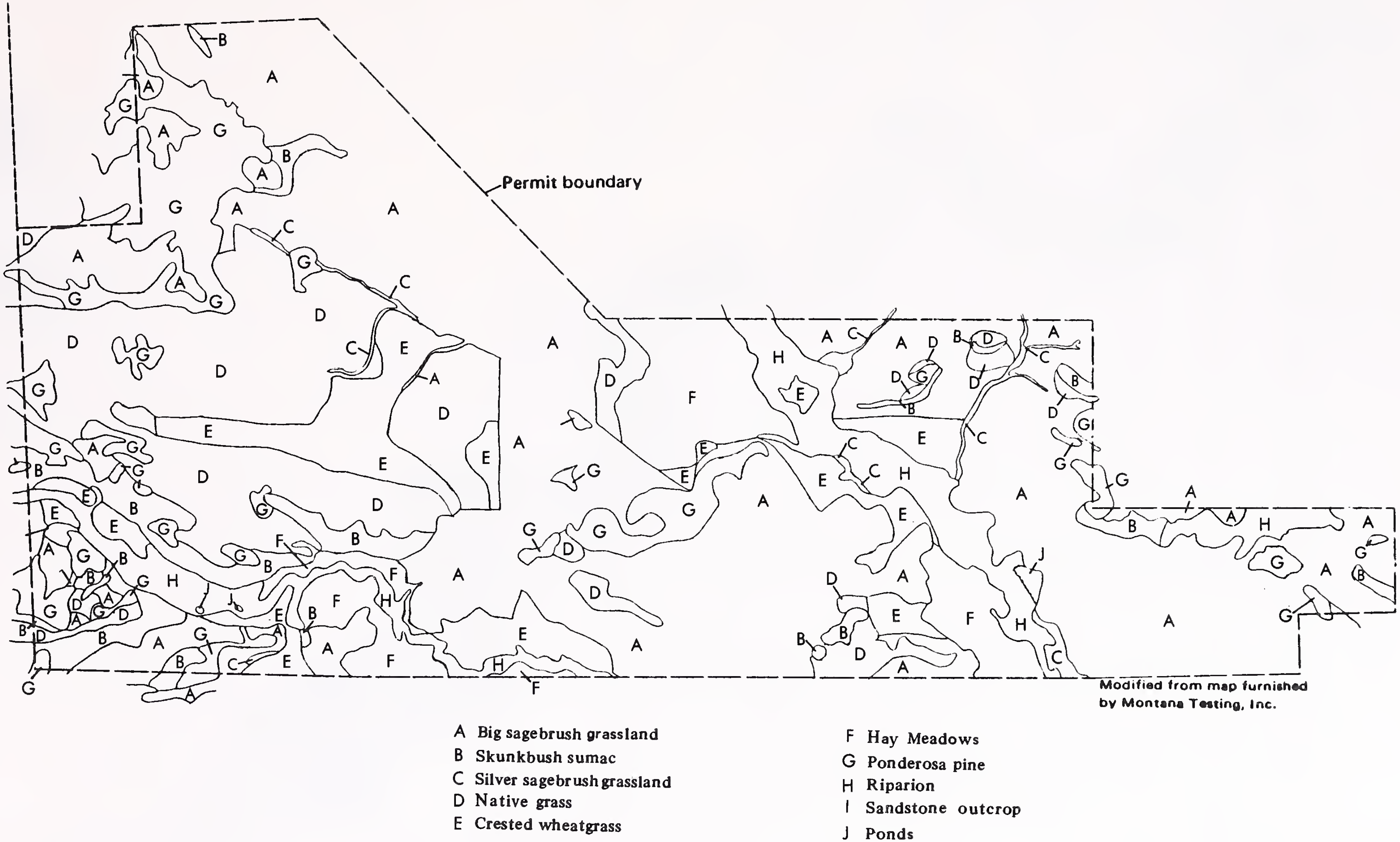

Figure II-9.—Vegetation map of the Pearl area.

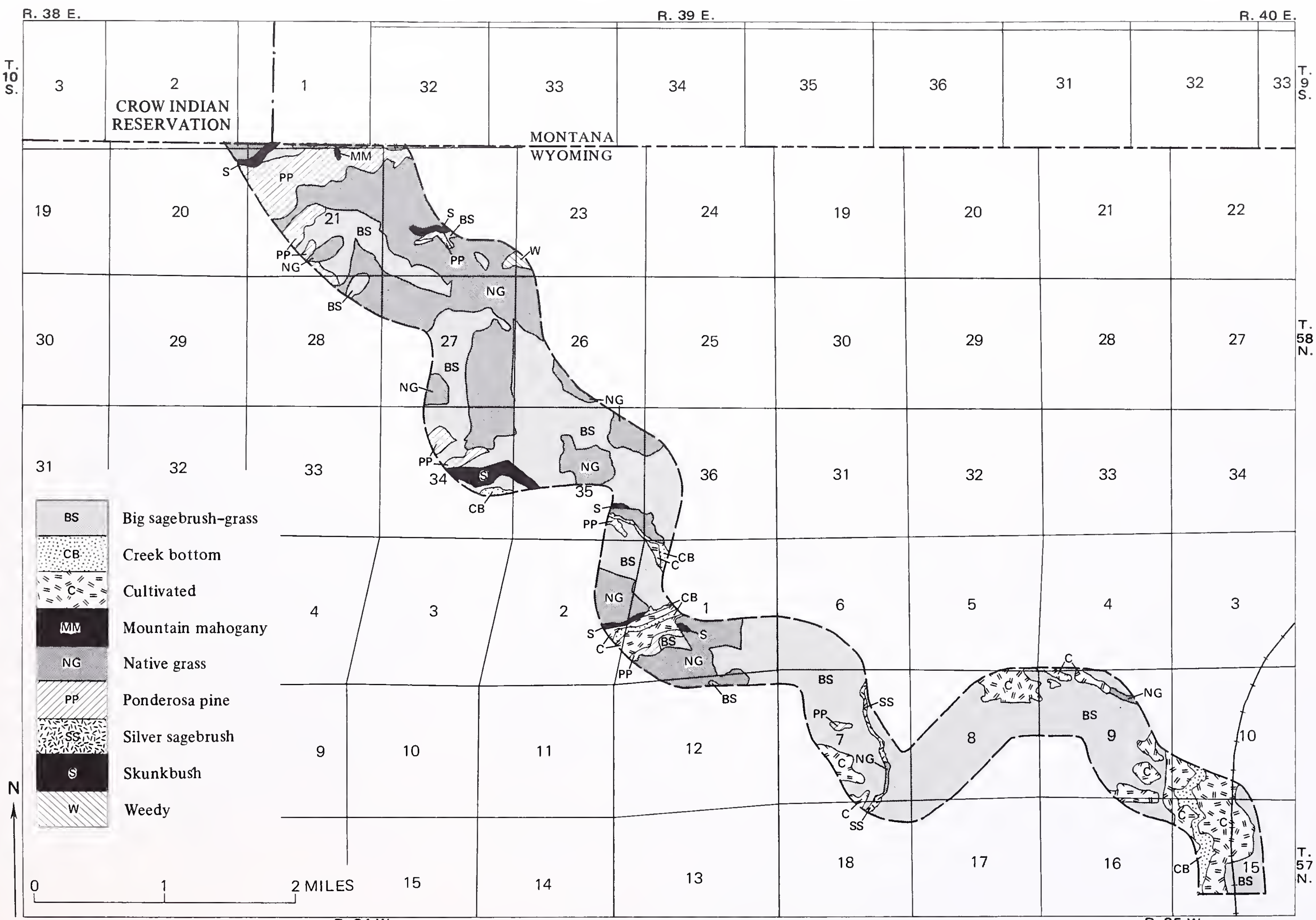

Figure II-10.—Vegetation types along the rail corridor.

TABLE II-10.--Growth forms and associated vegetation types in the Pearl area

Growth form	Vegetative type	Acres[1]	Percent	Associated soils types
Shrub-----	Big sagebrush-grass(A)[2]---	985	49	47C, 334D, 334E.
	Skunkbush-grass(B)--------	100	5	436D, 736D.
	Silver sagebrush-grass(C)-	20	1	502A.
Grassland-	Native grass(D)----------	320	16	334E, 421C, 736D, 736E.
	Crested wheatgrass(E)----	175	9	25C.
	Hay meadow(F)------------	140	7	12B.
Forest----	Ponderosa pine(G)--------	150	7	436D, 736D.
Woody-----	Riparian(H)--------------	115	6	502A.
Sandstone-	(I)----------------------	15	1	---
Pond------	(J)----------------------	5	T[3]	---
	Total-------------	[5]2,025	[4]101	

[1]Rounded to nearest 5 acres.
[2]These letters designate these types and are used in figure II-9 and table II-12.
[3]Less than 0.25 percent.
[4]Excess due to rounding.
[5]This acreage includes 563 acres adjacent to the permit area.

types in the rail corridor are similar (table II-10, table II-11; fig. II-9, fig. II-10; appendix G).

1. Agricultural Lands

The limited agricultural land within the study area is composed of cultivated pastures, hay meadows, and old cultivated fields which have since been either seeded to an introduced grass species or abandoned. Generally, these lands are used for hay production and not for a cash crop; small acreages are also utilized for supplemental food production. Production figures are not currently available but hay yields in this soil should range from 1 to 1.5 tons/acre, under favorable conditions (flood irrigation). Crested wheatgrass, smooth brome, and alfalfa are the major hay species used in the area.

TABLE II-11.--Growth forms and associated vegetation types in the Pearl mine railroad corridor in Sheridan County, WY

Growth form	Vegetation type	Acres[1]	Percent[2]	Soils type
Shrub------	Big sagebrush-grass----	2,685	49	47C, 334D, 334E.
	Skunkbush-grass--------	205	4	436D, 736D.
	Silver sagebrush-grass-	45	1	502A
Grassland--	Native grass-----------	1,730	30	334E, 421C, 736D, 736E.
	Cultivated-------------	405	7	---
Forest-----	Ponderosa pine---------	525	9	436D, 736D.
Woodland---	Creek bottom-----------	180	3	---
	Mountain mahogany------	5	T[3]	---
Steppe-----	Weed-------------------	45	1	
Total		[4]5,285	104	

[1]Rounded to the nearest 5 acres.
[2]Rounded to nearest percent.
[3]Less than 0.1 percent.
[4]291 acres of this would be right-of-way.

2. Natural Vegetation

Natural vegetation is typical of mixed short and mid-grass prairie plant communities dominated by drought-resistant grasses and shrubs. The riparian vegetation grows along drainages. Ponderosa pine forests and "savannahs" occur on north-facing slopes or swales where soils are rocky, stony, or otherwise underdeveloped, but which have favorable moisture penetration.

The Pearl area vegetation can probably support 30 to 35 animals per year, averaging 6 acres per animal per month (326 AUM's) (appendix H); 1976 figures indicated that about 80 to 90 animals grazed in the area throughout the year, including about 65 to 70 cows and 15 to 20 ponies and horses (approximately 900 AUM's). Grazing use has since been reduced.

a. Big sagebrush-grass type

Two basic big sagebrush subtypes dominate the study area. The big sagebrush/bluebunch wheatgrass subtype occurs primarily on steeper slopes and ridges but is also found on lower slopes where soils are thin or poorly developed. The big sagebrush/western wheatgrass subtype occurs on fairly level areas and commonly is dominant in swales or sloped inter-

mittent drainages, topographically below the big sagebrush/bluebunch wheatgrass subtype.

The big sagebrush/western wheatgrass subtype includes two phases in the Pearl area, which are good indicators of range condition: the green needlegrass phase (good condition) and the prairie junegrass phase (poor to fair condition).

b. Skunkbush-grassland type

This type occurs on steep rocky slopes where soils are derived from scoria and sandstone. It is found most often on south-facing slopes where cover and production are relatively low, and occasionally on north-facing slopes, where cover, production, and species diversity are much greater. The dominant shrub, skunkbush sumac, is an important browse species for mule deer and is regularly grazed by cattle.

c. Silver sagebrush-grass type

This type, dominated by silver sagebrush, is not common in the study area and is limited to gently sloping drainages in well developed loams that often are subirrigated. Most stands in the study area are in poor to fair range condition.

d. Native grass type[3]

Basic subtypes of grasslands in the study area include bluebunch wheatgrass/junegrass, needle-and-thread/western wheatgrass and annual grass. The bluebunch wheatgrass/junegrass subtype is the most abundant grassland in the area. It occurs on fairly flat to fairly steep slopes on all aspects. It is found mainly on loam or stony loam soils. Bluebunch wheatgrass is generally the dominant grass, although prairie junegrass is codominant in some areas. This type generally is in fair condition.

The needle-and-thread/western wheatgrass subtype is not common in the study area and occurs only on a south 10-percent slope on a sandy loam. Several perennial grasses, including needle-and-thread, western wheatgrass, blue grama, bluebunch wheatgrass, green needlegrass, Indian ricegrass, junegrass, and prairie reedgrass, make this type high in species diversity.

The third grassland subtype in the area is annual grass. This subtype indicates disturbance or overgrazing, after which Japanese brome and cheatgrass have replaced perennial grasses as dominants. With decreased use and increased rainfall, western wheatgrass is increasing.

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[3]Areas in which sagebrush have been sprayed and where remnants of dead brush are evident are classified as grassland types.

e. Ponderosa pine type

All ponderosa pine forests or "savannahs" are grouped into this type, which includes several phases: the juniper phase, the deciduous shrub phase, and the bluebunch wheatgrass phase.

Savannahlike stands of pine generally have a bunchgrass understory, whereas those on more moist, northerly slopes have a shrub understory including skunkbush, snowberry, and rose. Understory cover decreases with increasing pine canopy and litter accumulation.

Juniper is present in all sample stands and is codominant or dominant in the eastern part of the study area north of Youngs Creek.

A sampling of trees in 1976 indicated that most mature trees were between 56 and 72 years old. This, and remaining stumps, indicate the area was logged during the homestead era (1900-20). Most pine stands are spreading, and seedlings and saplings are common within and on the edges of the stands.

Range condition is generally better in the pine type than in adjacent types, as most stands are in fair to good condition.

f. Riparian type

The riparian type in the study area includes the deciduous tree and the grass/sedge phases, which are both restricted to the bottoms of Youngs and Little Youngs Creeks. Slopes are generally flat and soils are subirrigated or subject to creek overflow. Silty clay loams, the main soils associated with riparian types in the study area, are some of the most productive. Consequently this type supports a greater diversity of animals than any other type within the permit area. This type is heavily grazed; hence, most of the areas it occupies are in poor to fair condition.

A third riparian phase, the deciduous shrub type, is rare in the area and was not mapped or sampled. It occurs in the western part of the study area along creek bottoms. Snowberry, rose, skunkbush, chokecherry, and other shrubs are dominant.

g. Rare, endangered, and noxious species

There are no known rare or endangered species in the study area.

Big Horn County and the State of Montana have designated three species known to exist in the permit area which are noxious: Canada thistle (*Cirsium arvense*), field morning-glory (or field bindweed, *Convolvulus arvensis*), and wild licorice (*Glyccorhiza lepidota*).

G. WILDLIFE

Vegetative types and topographic relief in the Pearl area provide a diverse habitat for wildlife (table II-12). The most prominant vegetative types are sagebrush/grasslands, ponderosa pine stands, and deciduous riparian creek bottoms. Topography ranges from relatively flat stream valleys to rolling sagebrush/grassland and ponderosa pine hills to sandstone cliffs. A wildlife species list is presented in appendix I.

TABLE II-12.--Habitat types and corresponding vegetative types

Habitat types	Vegetation types[1]	Acres
Upland shrub----	A,B,C	1,105
Grassland-------	D,E,F	635
Ponderosa pine--	G	150
Riparian--------	H	115
Sandstone-------	I	15
Pond------------	J	5
Total----------------		2,025

[1]These correspond to vegetation types listed in table II-10.

1. Mule Deer

Mule deer occupy portions of the Pearl permit area year-round. Aerial surveys indicated that mule deer wintered, in 1976-1977, on the steep open ridges on the north and east peripheries of the Pearl permit area (fig. II-11): as many as 24 mule deer were counted in a single group.[4] A second wintering area was the ponderosa pine-covered hills on the west and south peripheries of the lease (fig. II-11).

Mule deer distribution by habitat type is shown for the general area adjoining the Pearl permit area in table II-13. Creek bottoms and draws adjoining creek bottoms were preferred habitats at night in both the summer and winter periods. Ponderosa-pine stands on the Pearl area were important as bedding/cover areas during the day. Wintering areas were characterized

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[4]Mule deer population within the Pearl area could not be accurately estimated by ground surveys due to the small size and irregular shape of the area, the seasonal movements/concentrations of the deer, and the scope of the study. Aerial survey estimations indicate a minimum of about 1 deer per square mile. 1.5 deer per square mile is probably a more accurate estimate.

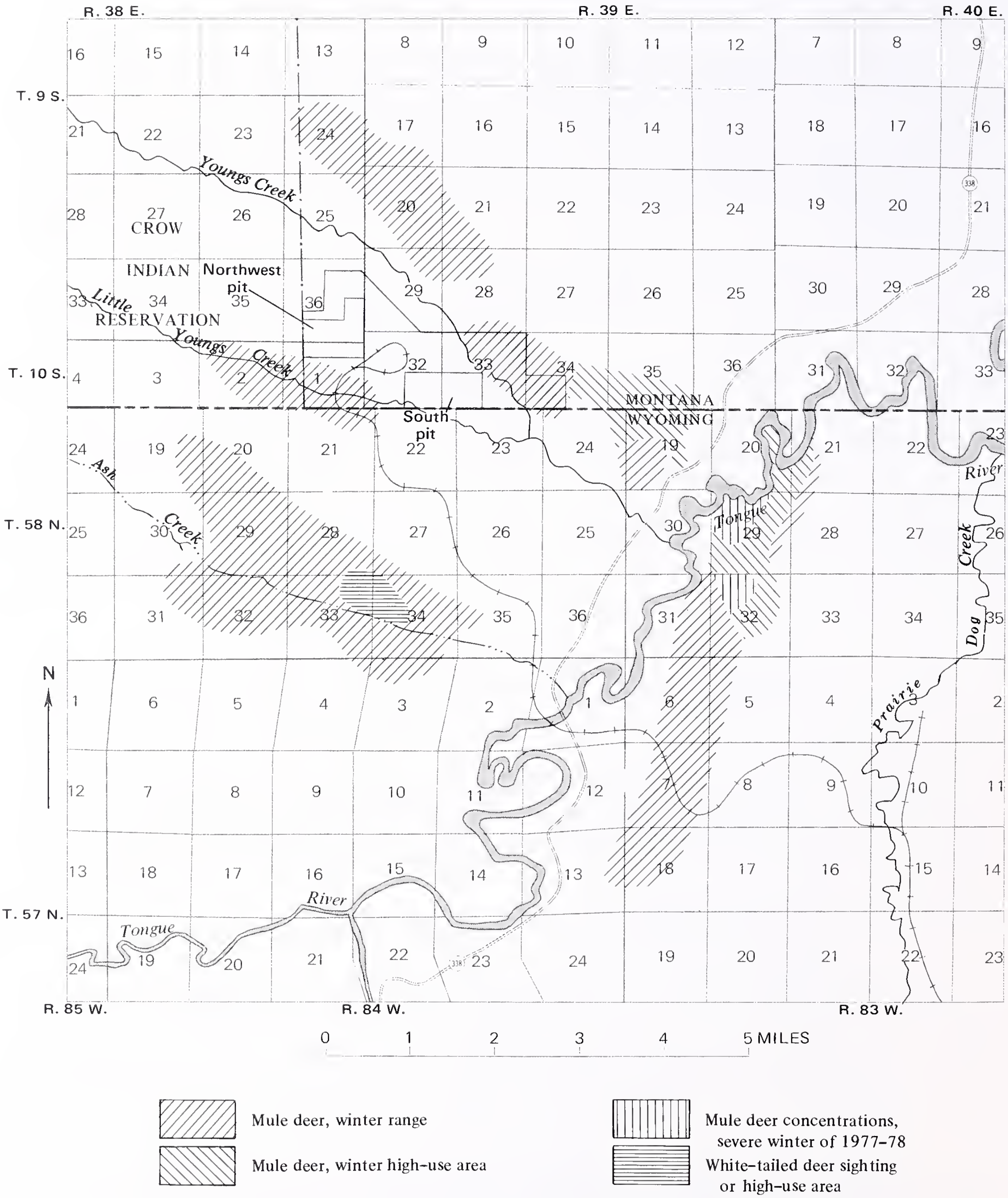


Figure II-11.—Deer winter ranges.

by steep slopes and proximity to creek bottoms, whereas use of the Pearl area in the spring, summer, and fall was more generalized. Big sagebrush within the upland shrublands habitat type was utilized as a primary food source; of the sightings in this habitat type, about 80 percent were recorded in morning and evening feeding periods. Grassland and cultivated (agriculture) habitat types are relatively little used by mule deer (Farmer, 1977).

TABLE II-13.--Mule deer observations by habitat type Pearl lease area, 1976-77[a]

Habitat type	Observations[b]	Percent
Upland Shrub------------ (includes sagebrush/ grassland)	65	54.6
Grassland---------------	5	4.2
Agriculture-------------	17	14.3
Riparian----------------	3	2.5
Ponderosa pine/juniper--	29	24.4
Totals-----	119	100.0

[a]Information source: Farmer, 1977.
[b]Groups of animals.

2. Antelope

Pronghorn antelope use the Pearl area seasonally. Baseline data did not afford a population estimate; however, Montana Fish and Game Department survey of hunting district 742 (including the Pearl area) in 1974 indicated a density of 0.5 antelope per square mile. Antelope production in the Pearl vicinity ranges from 70-75 fawns per 100 does. Farmer (1977) stated that antelope fawned on or near the Pearl area in 1976.

Antelope have been observed almost exclusively in the western half of the permit area. Summer use appears to be widely dispersed; fall use occurs largely west and south. Antelope wintered on the Youngs Creek bottom in 1975-76 (fig. II-12); however, ridges approximately 1.5 to 2 miles north-northeast of the Pearl area were used in 1976-77. Two key wintering sites, located in the Ash Creek and Prairie Dog Creek drainages, would be dissected by the proposed Shell railspur. These sites are probably near their carrying capacity under severe winter conditions such as occurred in the winter of 1977-78. Spring sightings were largely to the south of the Pearl area. Movements across the lease area are likely when antelope shift between seasonal ranges.

Habitat types, ranked in decreasing order of importance to antelope based on the amount of use, were grassland, upland shrub, agricultural, and ponderosa pine (table II-14). Most of the antelope observations

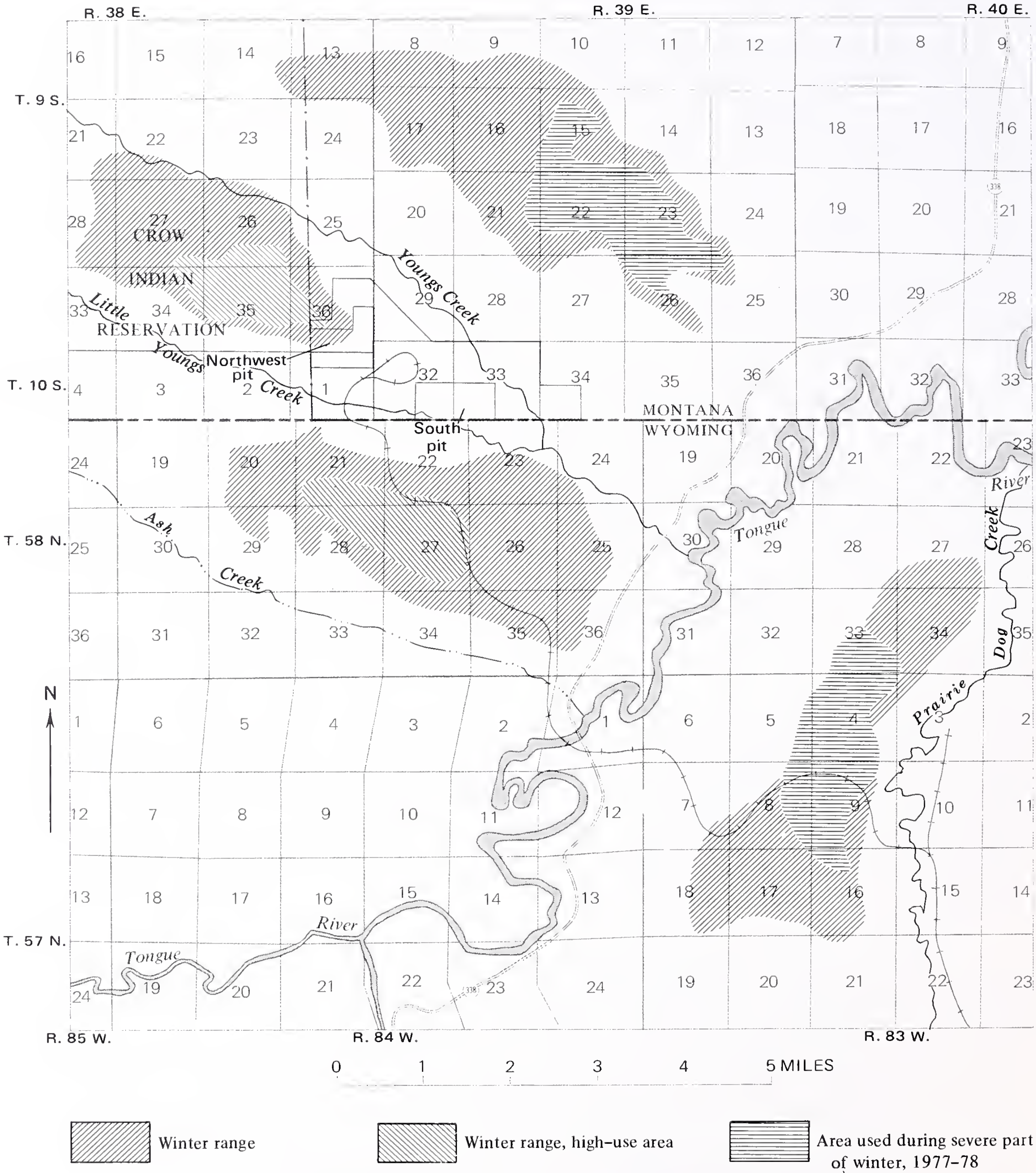


Figure II-12.—Antelope winter ranges.

attributed to upland shrublands were on big sagebrush-grasslands. Sagebrush is an important food source during the winter.

TABLE II-14.--Pronghorn antelope observations by habitat type Pearl lease area, 1976-77[a]

Habitat type	Observations[b]	Percent
Upland Shrub-------------- (including sagebrush/ grassland)	11	23.4
Grassland-----------------	25	53.2
Agriculture---------------	8	17.0
Riparian------------------	0	0.0
Ponderosa pine/Juniper----	3	6.4
Totals------	47	100.0

[a]Information source: Farmer, 1977.
[b]Groups of animals.

3. White-tailed Deer

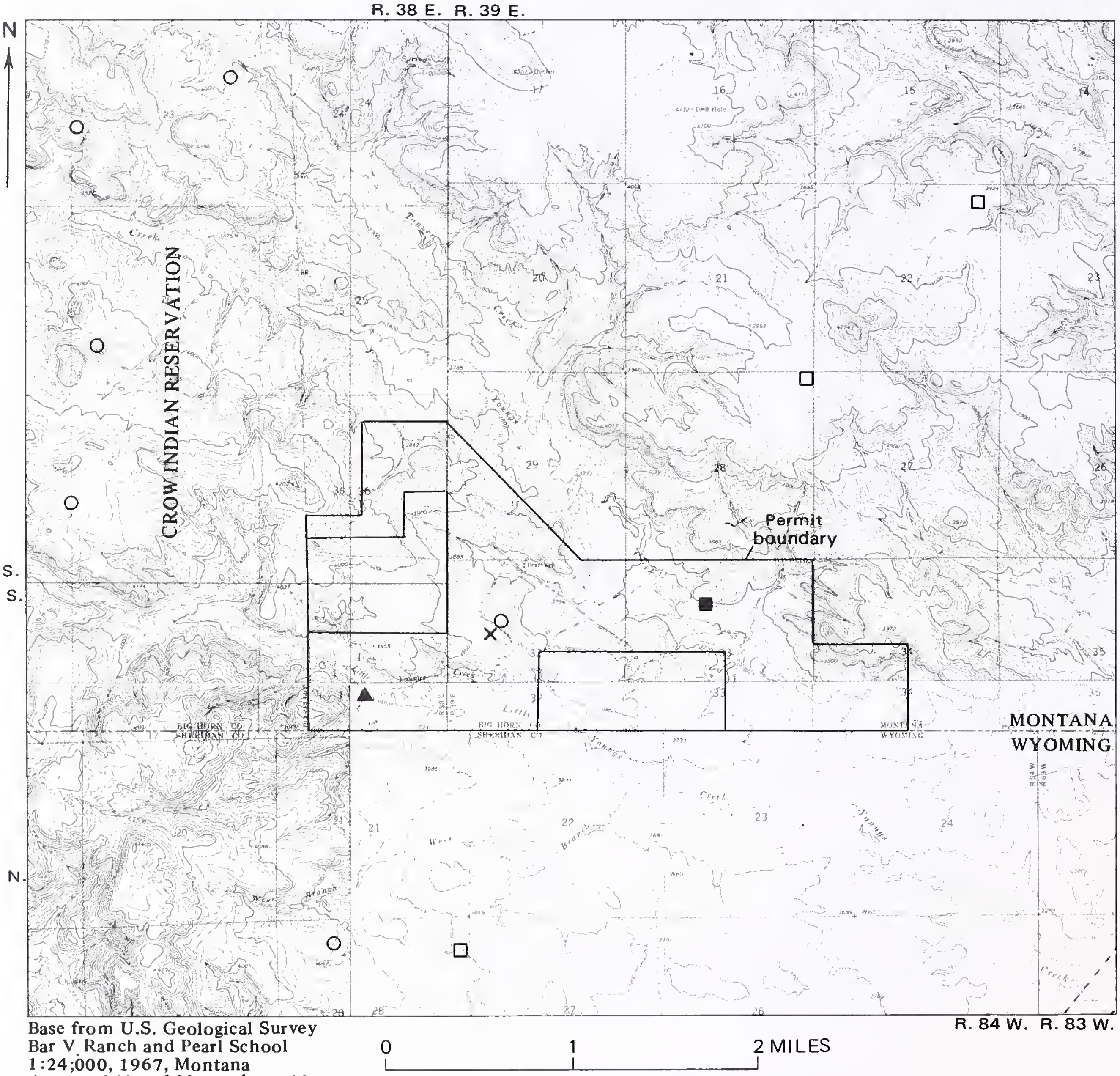
Approximately 90 percent of the observations were within one-quarter mile of a creek bottom, while 54 percent were in riparian habitat. White tail use of the Pearl permit area was observed in the spring, primarily in the Little Youngs Creek drainage, suggesting possible importance of the drainage as a fawning area.

4. Other Mammals

Sixteen species of rodents and three of rabbits have been observed on the Pearl area. Deer mice are the most common and widely distributed small mammals. The sagebrush-grassland habitat appears to be the most important for maintaining the diversity of small mammal species.

About 5 deer mice per acre occurred in the sagebrush-grasslands, which is their preferred habitat, and prairie voles and thirteen-lined ground squirrels were largely in the big sagebrush/western wheatgrass subtype. White-tailed jackrabbits have been observed only in the big sagebrush-grassland habitat subtype, mountain cottontails in riparian habitats along Little Youngs Creek, and desert cottontails, the most abundant species, in rock outcrops (probably for dens) and sagebrush-grassland habitats.

An active black-tailed prairie dog town on the permit area (fig. II-13) contained 19 individuals in July 1976; 14 in August; 14 in November; and 49 in May 1977. Muskrats, raccoons, and mink, and/or their signs, were sighted in the Youngs and Little Youngs Creek drainages. Bobcats make some use of the eastern portion of the permit area and coyotes are common throughout.



Base from U.S. Geological Survey
Bar V Ranch and Pearl School
1:24,000, 1967, Montana
Acme, 1968 and Monarch, 1964
1:24,000, Wyoming

○ Sharp-tailed grouse leks
□ Sage grouse leks
× Rattlesnake den
■ Prairie dog town
▲ Ring-necked pheasant winter concentration area

Figure II-13.—Wildlife concentrations.

5. Raptors

Of eleven raptorial species identified on the Pearl area, six nest on or immediately adjacent to the area (fig. II-14). Golden eagles, prairie falcons, red-tailed hawks, American kestrels, great-horned owls, and long-eared owls are nesting species of the Pearl vicinity. Turkey vultures, rough-legged hawks, and marsh hawks use the Pearl area seasonally. Coopers hawk and short-eared owls have been sighted on the area, but are a rare occurrance.

Three golden eagle nests were located within 1-1/2 miles of the Pearl permit area. Active red-tailed hawk nests were located within and immediately adjacent to the Pearl permit area in cottonwood and Ponderosa pine trees. Preferred prairie falcon nesting sites include the local sandstone cliffs of adequate height. Cliffs immediately adjacent to the Pearl area (fig. II-14) support several prairie falcon eyries. American kestrels are probably the most abundant birds of prey on the permit area. They use a variety of nest sites, including natural tree cavities, abandoned woodpecker holes, magpie nests, and cliff sites -- all available on or near the Pearl area. Nest sites can be very difficult to locate; only three probable locations were found during the study.

There were three known great horned owl nests on or immediately adjacent to the Pearl area. Great horned owls use a variety of nest sites, including magpie nests. Because of their secretive habits, additional undiscovered nests may exist in the vicinity. A long-eared owl nest on the Pearl site has been used intermittently. This nest was not occupied in 1977, although long-eared owls were occasionally sighted within one-half mile of the nestsite.

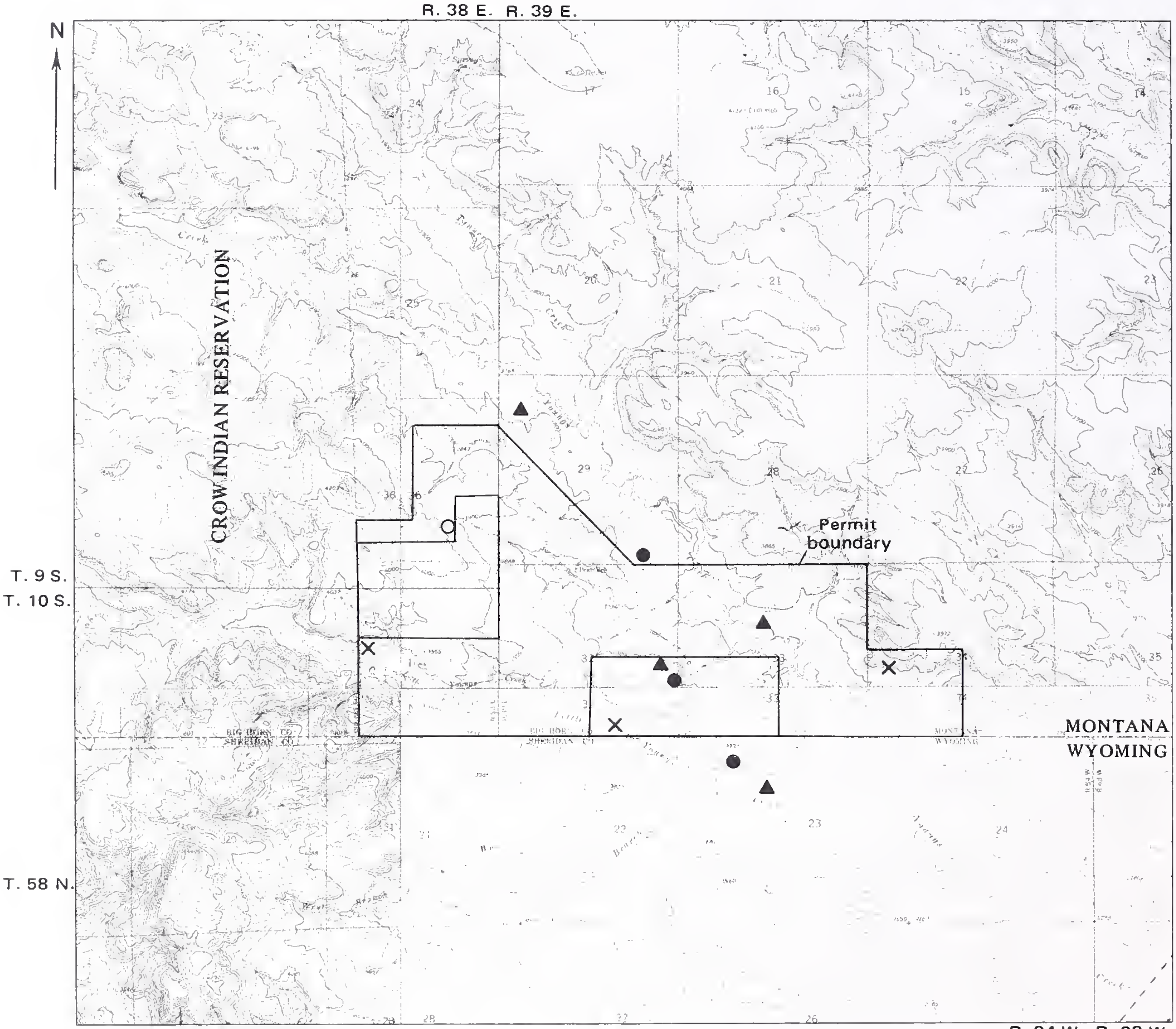
Cottontail rabbits and prairie dogs are the most important prey for large raptors using the Pearl area. Analysis of pellets regurgitated by great horned owls suggests that small rodents may also constitute a significant food base for raptors of the Pearl area.

6. Upland Game Birds

The Montana Fish and Game Department has classified the Pearl area as prime (Class I) sharp-tailed grouse habitat. Grasslands, shrub-grasslands, brushy coulees, and stands of ponderosa pine typify the western part of the lease area and the lands to the north and west of the lease area used by sharptails.

A sharp-tailed grouse lek located on the Pearl permit area is important to mating activities of local sharptail populations (fig. II-13). The greatest number of birds flushed from the lek was 14.

No sage grouse leks were located on the Pearl area during the premining study. However, 4 are within 3 miles of the area, 2 to the north and 2 to the south (fig. II-13). Sage grouse were observed during the summer



Base from U.S. Geological Survey
Bar V Ranch and Pearl School
1:24;000, 1967, Montana
Acme, 1968 and Monarch, 1964
1:24,000, Wyoming

▲ Red-tailed hawk nests
● Great horned owl nests
× American kestrel nests
○ Long-eared owl nests

Figure II-14.—Raptor nesting sites.

and fall months. The largest group was 16-20 birds, observed in September 1976, on the western portion of the permit area.

Nesting sites are typically in sagebrush having 15 percent canopy coverage or greater (Wallestad and Pyrah, 1974). During the brooding and summer periods, sites of comparatively sparse sagebrush density are selected. Because of past sagebrush control efforts, the Pearl permit area is presently considered suitable for summer use by sage grouse but inadequate as wintering and nesting sites.

A flock of 43 turkeys was flushed from riparian habitat of Little Youngs Creek in November 1976. The estimated population level for late fall was 50-60 turkeys in the Little Youngs Creek area. The Pearl area turkey population originated from a small flock of three hens and two gobblers on the J.V. States Ranch, on Little Youngs Creek, that later turned wild (Farmer, 1977, pers. comm.).

Most of the turkey sightings were in subtypes of ponderosa pine and agriculture habitats. Use of the ponderosa pine/deciduous shrub subtype appeared to be entirely during the spring. The pasture subtype was used during both the spring and fall. Riparian habitats appeared to be important fall-use areas. A large cottonwood tree near the States Ranch has been a traditional roost since the introduction of the flock.

Hungarian partridge were observed during all four seasons although only occassionally during the spring, summer and fall. A covey of 8-15 birds was observed on 3 occasions during the winter in alfalfa fields along Youngs Creek near the north boundary of the permit area. Hungarian partridge habitat is minimal on the permit area, probably due largely to elimination of grain crops and emphasis on livestock production. Big upland shrub was the habitat subtype predominantly used during the spring, summer, and fall.

The ring-necked pheasant population of the Pearl area has been declining somewhat in parallel to a general decline in southeastern Montana since 1954. No harems were observed nor nests found during the study period, although pheasants have been seen at times above the J. V. States Ranch along Little Youngs Creek. Pheasant use the riparian habitats of both Youngs and Little Youngs Creeks.

Due to intensive livestock grazing on riparian habitat of the Pearl permit area, waterfowl nesting sites may be limited or nonexistent. Stopover by migrant groups probably is the predominant waterfowl use of the area. Proctor and others (1974) have suggested that the nearby area provides only limited waterfowl habitat.

7. Songbirds

Preliminary studies indicate that the riparian habitat supports 37 songbird species, and the ponderosa pine 26 species. The sage-grassland

supports more species (10) than the grassland (6). A species list compiled by Mikol (1977) is appended (appendix I).

8. Reptiles and Amphibians

Prairie rattlesnakes are the most encountered snake species in the study. The den shown in figure II-13 was active in 1976. Most rattlesnakes were observed in the big sagebrush/grassland habitat subtype associated with rock outcrops. Bull, racer, and garter snakes have also been observed in the area. Painted turtles are common in ponds along Youngs and Little Youngs Creeks. Both sagebrush and short-horned lizards are common in rock outcrops and less common in the big sagebrush-grassland subtype. Chorus frogs were common in ponds, while leopard frogs were frequently seen along both creeks.

9. Fisheries

Fish are very limited to nonexistent in Youngs and Little Youngs Creeks, respectively (Olson-Elliot & Associates, 1977). The sport fishery in Youngs Creek can be considered low quality because it is composed primarily of non-game species of the sucker and minnow families.

10. Endangered Species

There are no records of rare, threatened, or endangered wildlife species on or near the Pearl permit area. One prairie dog town known to occur on the permit area is potential habitat for the endangered black-footed ferret. However, inspections of that town (Farmer, 1977) revealed no evidence of ferrets.

H,I. SOCIOLOGY AND ECONOMICS

The already impacted areas in southern Big Horn County, Montana, and Sheridan County, Wyoming, would be the areas most socially and economically impacted by the Pearl mine. A detailed description of the existing social and economic conditions in these areas is presented in the regional statement, chapter II.

J. COMMUNITY SERVICES

The community services in the impact area include housing, water, waste water, solid-waste disposal, schools, libraries, law enforcement, fire protection, and health care. The existing facilities and their capacity are discussed in the regional statement, chapter II.

K. LAND USE

The 1,462 acres included in the Pearl mine permit area is predominantly used for livestock grazing, wildlife habitat, and watershed. About 180 acres of this is cropland scattered in fields along Youngs Creek and Little Youngs Creek.[5] These fields are generally used for alfalfa hay, grass hay, or intensively managed pastures. None of these fields would be disturbed by pit or mine facilities. An additional 58 acres of formerly cultivated land near the proposed rail loading loop has been reseeded to permanent grass.

Two residences are in the study area, although neither is on land to be directly disturbed by the mine.

About 2-1/2 miles of county road connecting with Wyoming Route 338 crosses the study area. One-half mile of this road traverses the proposed south pit site.

Sheridan-Johnson REA provides the Youngs Creek area with electrical services. A 7.2 kV line from Wyoming extends for several miles up Youngs Creek and provides service at 13 locations in Montana; four within the study area.

A branch line of the Range Telephone Cooperative of Forsyth, Montana, serves Youngs Creek customers. This line also originates in Wyoming and parallels the road and powerline across the proposed south mine pit.

No other public roads or rights-of-way are included within the application area.

Lands surrounding the application area are thinly populated and rural in character, predominantly used for livestock grazing. Some along Youngs Creek and other tributaries of the Tongue River are used for cropland. In contrast to this pastoral landscape is the small Ash Creek mine (PSO mine No. 1) operated by Public Service Company of Oklahoma (PSO) immediately south of the application area in Wyoming. The total area committed to this mine is 286 acres.

Land use in the surrounding region is described in chapter II of the regional statement.

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[5] Air photos showing field patterns were used to estimate the acreage of past and presently cultivated lands. U.S. Dept. of Agriculture, ASCS Office, Hardin, MT.

L. TRANSPORTATION SYSTEMS

1. Highways

Figure II-15 shows the highway system and traffic load in the study region. Since most roads follow stream valleys, travel between some points is indirect. The Pearl minesite is accessible from Wyoming Federal Aid Secondary (FAS) Route 338 by approximately 4 miles of gravel surfaced county road. The Wyoming portion of the county road was recently regraded, and usually is maintained in good condition. North of the Montana border, the road is narrow and built to minimal grade standards. Beyond the minesite, the road continues in a northwesterly direction up Youngs Creek into the Crow Reservation.

All-weather highway connections are good to the south, where FAS 338 joins I-90 and U.S. 87. Most northbound traffic from the Pearl site would take the somewhat circuitous route south to I-90, west via Ranchester, and then north through Lodge Grass and Hardin. Travelers may also turn north on FAS 338 (which becomes FAS 314 in Montana) to make connection with U.S. 212 near Busby. A major part of this route north of the Decker mine has only a gravel surface.

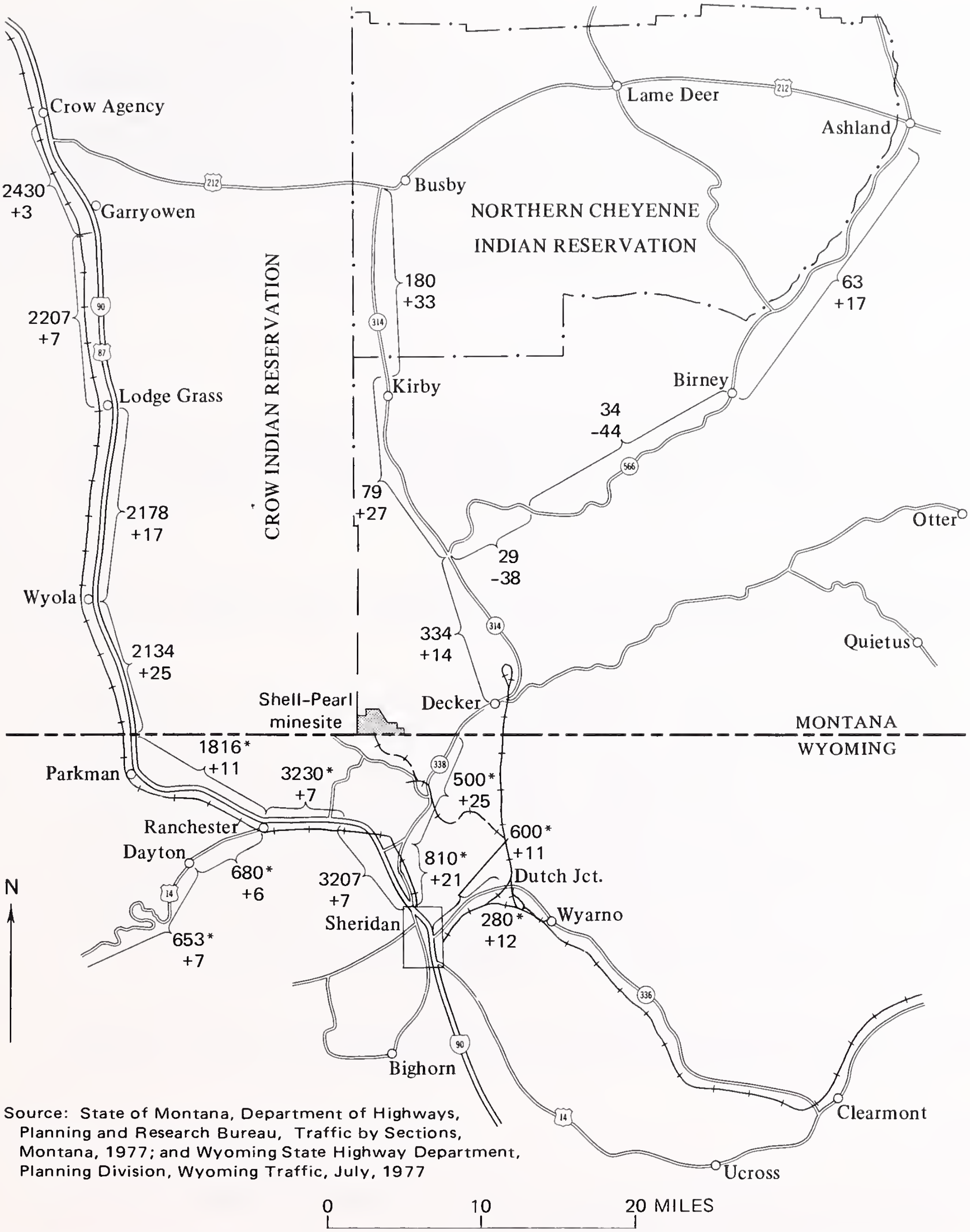
Traffic on FAS 338 and 314 has increased substantially in the last few years. Figure II-15 shows average daily traffic (ADT) counts on highway segments near the proposed mine in 1976 or 1977 and the percentage increase over the period 1975-76. Segments of FAS 338 and 314 are proposed by the State Highway Departments for future reconstruction. Much of the present traffic on FAS 338 and 314 is generated by the Big Horn and Decker mines. The much smaller Ash Creek mine lies at the end of the improved county road leading to the Pearl site. Traffic generated by this mine would also use the FAS 338 route. Ash Creek mine has not yet entered the production phase. In the past, FAS 338 and 314 served largely as a farm to market road, as recreational access to Tongue River Reservoir, and as a secondary connection between the Sheridan area and U.S. 212 in Montana.

A low-quality dry weather dirt road connects I-90 with U.S. 87 near Ranchester and the county road serving the Pearl site. It reduces travel distance by a few miles between the Pearl site and points west or north; however, its present condition limits use.

2. Railroads and Other Transportation

A 15-mile extension of the Decker spur, which currently handles about 3 unit-trains per day, would be built to the Pearl mine. A detailed description of the existing system and its capacity is presented in the regional statement.

Other transportation available in the region is also described in chapter II of the regional statement.



Source: State of Montana, Department of Highways, Planning and Research Bureau, Traffic by Sections, Montana, 1977; and Wyoming State Highway Department, Planning Division, Wyoming Traffic, July, 1977

2207	Average number of all vehicles per day, 1977	(336)	Federal Aid Secondary or State Route numbers
+7	Percent change in 1977 count over 1975		
653*	Wyoming data are for the year 1976	—+—+—	Burlington Northern Railroad
+7	Percent change from 1975 to 1976	—+ —+ —+	Proposed railspur extension

Figure II-15.—Local road and rail system and average daily traffic (ADT) on rural road sections.

M. RECREATION

There are no developed recreation facilities in the proposed mine area. Some hunting, sightseeing, hiking and other dispersed forms of recreation may occur, but there are no use data available to substantiate this. Because the land is all privately owned, the opportunities for general public use are limited.

Offsite and urban recreation are discussed in chapter II of the regional statement.

N. CULTURAL RESOURCES

In 1977 an archeological survey of the proposed Pearl mine area recorded 16 archeological sites, consisting of 8 hunting camps, 1 rock shelter, 5 porcellanite workshops, 1 transient camp, and 1 base camp (Gregg, 1977).

No further work is recommended on 14 of the sites. Surface collections have been completed on those sites where potential destruction from the proposed mining operations would occur.

The remaining two sites, recommended for further work, qualify for consideration for nomination to the National Register of Historic Places. One of the sites (Bunny Chase 24BH1574) has already been studied and determined eligible for nomination. Data recovery at the Bunny Chase site was undertaken, under a finding of "no adverse effect" from the Advisory Council on Historic Preservation. No further work is required. The other site (Devastation Shelter) is currently being considered for eligibility for nomination to the National Register of Historic Places. Should this site be determined eligible, plans will be made to protect the site from associated vandalism or disturbance from mining.

Site locations are on file and may be viewed at the Department of State Lands in Helena and the Bureau of Land Management office in Miles City.

Historical

No historical sites have been identified within the Pearl mine area. (Western Interpretive Services, 1976).

O. ESTHETICS

The Pearl area, evaluated by using the Bureau of Land Management's Visual Resource Management System (VRM), has low to average scenic quality (Class C-8) and is in a VRM Class IV area (appendix J). Pine trees and shrubs grow in the hills in the northwestern and southern areas of the site, while a number of hay fields are present in the valley bottoms.

The adjacent Ash Creek mine, to the south, is a source of occasional blasting and vehicular noise. No other unusual sources of noise exist in the area. The predominant odors in the area are from the vegetation.

The proposed mining area has no unusual scenic qualities and is similar to other scenes throughout the area. Spoils piles from the Ash Creek mine, however, are visible from the slopes of the Little Youngs Creek drainage. The remainder of the permit area is rural in character, with limited evidence of manipulation by man.

CHAPTER III

ENVIRONMENTAL IMPACTS

A. GEOLOGY

Impacts to topography and geomorphology would not be significant on the minesite. The company has proposed a reclamation plan that would attempt to restore a geomorphically stable land surface. However, the land surface would still be subject to minor increased erosion. Part of this increased erosion is unavoidable under any mine and reclamation plan and would decrease to natural rates only as soil structure and premining infiltration characteristics redevelop. (See chapter II, regional volume.) Complete redevelopment would take perhaps hundreds of years. Additional increased erosion, however, is avoidable and might result from specific aspects of the proposed mine and reclamation plan (see chapter VIII); under the present plan, piping and severe hillslope erosion (rilling and possibly gullying) could locally limit land use, and the incision of the Youngs Creek channel could affect alluvial ground water. (See Ground Water, chapter III.) Impacts could be significant in that Shell Oil Company would probably apply for leases of the adjacent coal. Hence, a much larger area than is addressed here could be impacted.

1. Topography and Geomorphology

a. During mining

During mining the permit area would be subject to an unknown amount of increased erosion resulting from the removal of vegetation and the disturbance of the land surface. The natural surface drainage would be disrupted and replaced with a network of drainage ditches that would route stormflow and excess sediment from haul roads, the railroad loop, overburden and topsoil storage areas, and plant facilities to sediment settling ponds. Storm water and its sediment load would collect in the pit and would then be pumped to sediment settling ponds before its release downstream to Youngs Creek. The exact amount of increased erosion is not important from the geomorphic viewpoint because, with the exception of the railroad corridor, increased erosion would be confined to the permit area and reduced by reclamation. Steep hillslopes on roadcuts along the railroad corridor, mainly in Wyoming, would be subject to severe erosion during heavy rainstorms. This erosion would not produce a significant impact, because it would be confined to small areas along the railroad corridor, where the railroad line itself would more severely affect land use.

No information is available on the Little Youngs Creek diversion, and its susceptibility to erosion cannot be evaluated. If properly designed, erosion from this source would be minimal.

The most likely geomorphic impact would result from the removal of sediment from water released from the settling ponds into Youngs Creek. State and Federal regulations [ARM 26-2.10(10)-S10261 et seq.; 30 CFR 715.17(A)] allow these waters to carry a suspended sediment load of no

greater than 45 mg/L or approximately 45 ppm. Such waters are practically sediment free, and would increase stream discharge without significantly adding to its sediment load. Normally, when streamflows are increased by storm runoff, sediment load is also increased. Wilson (1972) reported that sediment concentrations of runoff from summer thunderstorms in the Western United States are in excess of 10,000 ppm. In comparison, the waters released by the sediment settling ponds would be sediment-deficient. Locally, channel incision would occur as the augmented streamflow cut into the channel floors or streambanks to obtain this sediment load. Stream incision should be avoided, otherwise the alluvial water table in adjacent parts of Youngs Creek alluvium could be lowered. (See chapter III, Ground Water.)

The amount of incision is difficult to predict. It depends upon the volume of sediment-deficient water released downstream: the greater the discharge released, the greater the amount of erosion. The volume of water that would be released depends primarily on the amount of ground water that accumulates in the pit and the rate of pumpage from the pit, but also is a function of the length of time that the settling ponds remain in place.

b. Reclamation

Reclamation of the 616 acres of natural topography disturbed at the northwest and south pits would be an ongoing process. Both pits would be restored to approximately original topography. Restoration of ephemeral stream channels, and integration of the reclaimed surface with the surrounding topography, would form a geomorphically stable landscape.

Some increased erosion, unavoidable under any mine and reclamation plan, would occur but should not significantly limit land use. (See chapter II, regional volume.) The reclamation surface would remain more susceptible to erosion and be less drought resistant than natural surfaces for a long period of time (possibly several decades) following reclamation. During this period, the reclaimed surface could develop severe erosion problems if misused, or during periods of drought. In addition, some excess erosion resulting from specific aspects of the reclamation plan might occur. This erosion could be reduced by altering the reclamation plan. On the northwest pit area, reconstructing hillslopes without the natural benches and breaks in slopes that existed in the premining topography could cause increased erosion. The more uniform reclaimed hillslopes have a greater effective slope length and, hence, would be more susceptible to erosion. Piping, a cause of gullying, could result when coarse-textured soils were placed over fine-textured compacted soils.

It is doubtful that runoff and sediment from a successfully reclaimed surface would increase sufficiently to affect the channel geometry of Youngs Creek or Little Youngs Creek.

Mining would disturb a short reach of Little Youngs Creek where it crosses the southwest corner of the south tract. The geomorphic stability of the reconstructed stream channel, and the probability of subsequent severe erosion cannot be evaluated because no specific information on

channel design is available. However, mining would disturb such a short reach of the stream that successful reconstruction should not prove difficult.

An additional 580 acres of surface topography would be modified for soil and overburden stockpile areas, surface facilities, sediment settling ponds, roads, and the railroad loop. Following mining, haul roads would be ripped, leveled, and revegetated. Settling ponds would be dried, covered, graded, and reseeded. Stockpile areas would also be reclaimed. The company has proposed to leave the surface facilities and the railroad loop for reuse by future mining in the area. The facilities and the loop would be removed, and these areas reclaimed at some unspecified time in the future. With successful reclamation, these areas would be similar to the reclaimed minesite and provide some unavoidable increased sediment and runoff for long periods of time.

2. Stratigraphy, Overburden and Interburden

Mining would irretrievably destroy the overburden stratigraphy as it now exists; however, this would produce no significant impact in itself: the local stratigraphy is not unique and has no intrinsic value.

Aquifers within the overburden would be destroyed, altering ground-water movement. (See Hydrology, Ground Water, chapter III.) Overburden material would be crushed and soluble minerals exposed to solution. The existing relationship among vegetation, soil, and bedrock would be disrupted making revegetation more difficult. Saline, sodic, and possibly toxic material within the overburden may be placed within the root zone during reclamation. Microsites favorable to the growth of specific vegetation types would be destroyed. As a result, the removal and replacement of overburden in the leasehold would alter the postmining soil and ground-water chemistry and could limit the success of revegetation.

3. Paleontology

Anticipated impacts are of negligible significance: no fossils of exceptional scientific interest are believed to exist in the overburden at the minesite.

B. HYDROLOGY

Impacts to surface water would probably not be significant. Increased erosion on the reclaimed surface (see Geomorphology, chapter III) would only slightly increase the sediment loads in the perennial streams. Sediment from the railroad corridor would reach the Tongue River only after long periods of time (decades) or during major storm events, and would not be great enough to cause a significant increase in the sediment load of the Tongue River. Surface flow in Little Youngs Creek could be reduced an unknown amount if mining lowers the alluvial water table. Mine waters would be temporarily added to Youngs Creek during mining, resulting in an

increased streamflow that might induce channel incision (see Geomorphology, chapter III), moreover, the mine waters would reduce water quality, although probably not enough to limit water use.

The principle impacts to ground water would be the destruction of portions of several bedrock aquifers, and the lowering of ground-water levels in adjacent bedrock and alluvial aquifers. Bedrock aquifers would be replaced by highly permeable spoils that would resaturate after mining. However, in the resaturated spoils, water would be of poor quality and would probably be unsuitable for either stock or domestic use. Ground water in both Youngs Creek and Little Youngs Creek alluvium might be lowered, reducing water availability to riparian vegetation and crops. The magnitude of this effect is potentially greater along Little Youngs Creek than along Youngs Creek. Springs along Little Youngs Creek, in the permit area, currently supplying domestic water, could dry up.

1. Surface Water

During mining, the lease area would be subject to increased erosion and sediment transport. An estimated 1,196 acres would be disturbed in varying degrees. The storage areas would be vegetated so that the sediment yield would be equal to assumed natural conditions of 1 acre-ft/mi^2. The railroad grade would primarily cross ephemeral streams and therefore would yield little sediment to the Tongue River. Sediment transport is discontinuous, and much sediment is stored along ephemeral streams. Therefore, many years (possibly hundreds) would be required for sediment to reach perennial streams. Where the railroad crosses perennial streams (Little Youngs Creek, Prairie Dog Creek, and the Tongue River) sediment would be directly added to the Tongue River system. However, the amount added should be too small to cause an overload.

Data are not currently available to fully analyze the impact of the diversion of Little Youngs Creek away from the southwest corner of the south mine area. No data are available relative to the dimensions, slope, construction material, or length of the diversion. Nor are data available to analyze the return of Little Youngs Creek to its former site, which would be on replaced spoils, alluvium, and colluvium.

Several small ephemeral or intermittent tributaries of Youngs and Little Youngs Creeks would be altered or removed as mining progresses (fig. II-1) but would be restored during reclamation. The disturbance of the land surface, the removal of vegetation, and the breaking up of any armoring material would increase local erosion until protective measures become effective.

The sediment yield resulting from mining and the first 4 years of reclamation would be approximately 32,200 tons[1] (table III-1), or

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[1]This sediment yield would be spread over 27 years of mining and reclamation and does not include the natural sediment yield that would be produced before an area is disturbed or 4 years after it is reclaimed.

TABLE III-1.--Expected annual sediment yield for mined areas

Year of operation	Disturbed acres unreclaimed	Sediment yield from unreclaimed acreage[2] (tons)[1]	Acres Reclaimed	Sediment yield from reclained acres (tons[1])[2] First year[3]	Second year[3]	Third year[3]	Fourth year[3]	Four years
1----------	66	450	0	---	---	---	---	---
2----------	103	705	0	---	---	---	---	---
3----------	102	700	25	170	170	85	70	495
4----------	113	770	19	130	130	65	50	375
5----------	117	800	26	180	180	90	70	520
6----------	124	850	14	95	95	50	40	280
7----------	128	875	18	125	125	60	50	360
8----------	129	880	20	135	135	70	55	395
9----------	136	930	18	125	125	60	50	360
10----------	136	930	22	150	150	75	60	435
11----------	144	985	18	125	125	60	50	360
12----------	142	970	21	145	145	70	55	415
13----------	140	955	22	150	150	75	60	435
14----------	144	985	21	145	145	70	55	415
15----------	163	1,110	33	225	225	115	90	655
16----------	129	880	54	370	370	185	150	1,075
17----------	103	705	50	340	340	170	135	985
18----------	104	710	20	135	135	70	55	395
19----------	103	705	23	155	155	80	65	455
20----------	114	780	22	150	150	75	60	435
21----------	109	745	26	180	180	90	70	520
22----------	103	705	21	145	145	70	55	415
23----------	103	705	20	135	135	70	55	395
24----------	84	575	19	130	130	65	50	375
25----------	59	405	25	170	170	85	70	495
26----------	28	190	31	210	210	105	85	610
27----------	0	0	28	190	190	95	75	550
Total----------------------		20,000						12,200

[1]Sediment yield estimates are rounded to the nearest 5 tons.

[2] Estimated sediment yields are based upon the following assumptions:

a) that the sediment yield from unreclaimed land and from land during the first two years of reclamation is 2.5 times the natural sediment yield (assumed 1 ac-ft/mi^2/yr);

b) that the sediment yield from reclaimed lands in the third year following reclamation is 1.25 times greater than the natural yield, and;

c) that the sediment yield by the fourth year has returned to approximately the natural sediment yield.

[3]Sediment yield estimates are provided for the first 4 years of reclamation. Estimated yield for these years should be lagged behind the year in which reclamation on the given portion of land was begun. For example: Eight acres of land are reclaimed during the second year of operation. By the fifth year (the fourth year of reclamation for this parcel), sediment yield would approximate the natural yield. Similarly, the 45-acres reclaimed during the final year of operation would produce approximately the natural sediment yield 3 years later.

approximately 2.2 times the sediment yield this area would have produced without the proposed operation. Assuming a density of 2,600 tons per acre-foot, this amounts to about 12.4 acre-feet of sediment. Approximately one-half of this amount of sediment would not have been produced without mining. Almost three-quarters of of this sediment would be produced from areas disturbed by mining, before their reclamation. This sediment would be collected in the pit, or would be routed to sediment settling ponds, and would probably not reach Youngs Creek or Little Youngs Creek. The remaining excess sediment would be produced following reclamation and could potentially reach the perennial streams. However, much of the sediment would deposit before reaching the streams, and the perennial streams would not be greatly affected. (See Geomorphology, chapter III.)

Potential sediment yield of the railroad spur was computed to be about 6.1 acre-feet for the 10-year period 1981-90. This computation was made by applying the following assumptions:

1. 290 acres would be disturbed in constructing the railroad grade.

2. Sediment yield for the first 2 years (prior to effective revegetation) would be 2.5 acre-ft/mi^2/yr.

3. Sediment yield for the third year with partial effective revegetation would be 1.25 acre-ft/mi^2/yr.

4. Sediment yield for the following 7 years would be equal to the assumed natural yield of 1.0 acre-ft/mi^2/yr.

Lowered water levels in the alluvium of Little Youngs Creek could decrease surface flow. In summer, when this impact would be the greatest, Little Young's Creek is not used for irrigation. Further hydrologic investigations are required to determine other impacts.

Most of the water pumped from the mine pits would be discharged to Youngs Creek. The amount of discharge is uncertain, but based upon available data it could at times be as much as 5 cubic feet per second (ft^3/s). Increased streamflow would benefit water supply and stream biota; however, at times it could increase the dissolved solids concentration of the stream. Table III-2 presents data on the Youngs Creek drainage collected above the below the PSO (Public Service of Oklahoma) Ash Creek mine where pit water is currently added to the stream. These data indicate increases in the total dissolved solids and most of the major chemical constituents. (Trace elements were much less affected; hence, their data are not presented.) At present it is unclear if the change in water chemistry is caused by the addition of pit water or irrigation. It is probably caused by both. However, addition of pit water from the Pearl mine to Youngs Creek could further increase the concentrations of the major constituents but should not be enough to be detrimental to the aquatic life in the streams or to render the water unfit for irrigating hay crops.

TABLE III-2.--Water quality of Youngs Creek drainage above and below PSO operation (data presented as range)

[Units in mg/L except for pH or as otherwise noted]

Analysis	Below the Ash Creek mine: Youngs Creek near highway	Above the Ash Creek mine: Youngs Creek primarily on Crow Reservation	Above the Ash Creek mine: Little Youngs Creek primarily on Crow Reservation
Ca--------	53-130	25-66	40-55
Mg--------	57-140	22-61	22-39
Na--------	26-340	2.0-28	10-19
K---------	6.1-14	0-11	3.4-6.5
CO_3-------	0-27	0-22	0-7
HCO_3------	301-660	218-410	240-286
SO_4-------	200-1,100	18-119	22-65
Cl--------	1.8-18	0.8-5.1	1.3-2.1
F---------	0.3-1.2	0.2-1.6	0.3-0.6
Specific conductance (μmhos/cm)--	790-2,800	380-740	400-510
pH--------	7.7-8.6	7.9-8.8	7.6-8.5
Hardness ($CaCO_3$)-----	391-900	193-404	210-259
TDS-------	524-2,240	233-486	257-331

The pond in SE1/4 sec. 1, T. 10 S., R. 38 E. may be impacted if it receives water from the alluvium of Little Youngs Creek. The pond located in the facilities area may or may not be affected by mining.

2. Ground Water

Portions of the aquifers within the pit perimeter would be destroyed during mining. Adjacent portions of these aquifers would discharge ground water into the pit.

The rate of inflow into the pit is difficult to predict, hydrologic studies of the minesite are not yet completed. The Ash Creek mine, immediately to the south of the proposed Pearl mine, has a relatively constant inflow of 200 gal/min. The Ash Creek mine however, does not intercept the alluvium of Little Youngs Creek. Mining in the southern tract at the Pearl site would encounter larger ground-water inflows. Inflow to the south pit would come from several sources: The M and G coal, the clinker, and, most importantly, from the alluvium along Little Youngs Creek. Large inflows would occur initially, probably several hundred gallons per minute, but they are not expected to remain large over the life of the mine.

Dewatering of the alluvial aquifer along Little Youngs Creek would occur both upgradient and downgradient from the south pit. The distance

affected by dewatering would be a function of recharge from surface flow, and of the diversion method used for surface and ground water around the south pit. Dewatering effects would probably be limited to a maximum of several thousand feet both downstream and upstream from the minesite.

During reclamation, Little Youngs Creek alluvium would be restored to its present location along the streambed. However, it is uncertain if the alluvium would be restored as an aquifer. At present, alluvium rests upon much less permeable bedrock. As a result, the alluvium is saturated and movement is downvalley. The alluvial ground-water table may feed surface flow. With reclamation, the alluvium would be placed upon relatively permeable spoils material (Rahn, 1976). If the boundary between the alluvium and the spoils is permeable, alluvial ground water, and possibly even surface flow, would decrease due to infiltration to the spoil. If this boundary is relatively impermeable, because of compaction by machinery during placement and grading, alluvial ground water would resume its downvalley movement, and surface water should be unaffected. (Mitigations are discussed in chapter VIII.)

Due to the poor hydraulic connection between the alluvium of Youngs Creek and the underlying bedrock aquifers, little impact is expected. However, the addition of sediment deficient waters, derived primarily from the inflow of ground water to the pit, could cause channel incision along Youngs Creek. (See Geology, chapter III.) As the stream downcuts, the adjacent alluvial water table would also be lowered. The amount of water table lowering would decrease away from the stream channel.

The lowering of the alluvial water table along Youngs Creek would be slight; the effect of this on riparian vegetation or crops is unknown. If regulatory agencies designate Little Youngs and Youngs Creek valleys as "alluvial valley floor" under SMCRA, this would require preservation of "essential hydrologic functions." This could make any lowering of these alluvial water tables significant and would require significant modifications of the plan.

Under the current plan, mining would breach hydrologic barriers (faults, fig. II-4) altering the direction of existing ground-water flow. After mining, where the faults are mined out, ground water would move to the southeast. Locally, northwest of the faults, the ground-water levels would be lowered. The portions of aquifers destroyed during mining would be replaced by a more permeable spoils aquifer.

The reclamation surface would have lower infiltration rates than the natural surface (see Soils, chapter III; Lusby and Toy, 1976; Arnold and Dollhopf, 1977) and recharge directly to ground water by infiltration would be reduced. The extent to which spoils would resaturate is unknown. Most of the water entering the spoils would come from lateral flow from bedrock aquifers, and additional amounts would come from the alluvium of Little Youngs Creek. This could cause a continued drain of water from the alluvial aquifer, which may preclude reestablishment of the original water table in this aquifer.

The quality of water in the spoils may be similar to that in the spoils at the Decker mine where the water is of the magnesium sulfate type and averages about 5,000 mg/L dissolved solids. This concentration would be unsuitable for stock or domestic use.

The water would move from the spoils downdip to the northeast in the G and M coal seams, but would be diluted by local recharge and mixing with waters from bedrock aquifers. (See appendix C for water quality of the G and M seams.) The suitability of mixed water for use by livestock is uncertain. It is unlikely that wells several miles from the mine would ever be seriously polluted by water from the mine spoils.

The water level in the unused well in the alluvium of Little Youngs Creek would be lowered by both mine pits, but this would not be significant. Lowered water levels in adjacent coal aquifers would affect an unused well in NW1/4SE1/4 sec. 20, T. 9 S., R. 39 E., probably a stockwell in the SW1/4SW1/4 sec. 22, and a well in the SE1/4SE1/4 of sec. 21. The latter two wells are approximately 2 miles downgradient from mining where drawdown effects should not be significant. However, the wells could undergo some water quality degradation. Wells northwest of the mine pit are separated from the mine by a major fault. The local breaching of this fault would cause some lowering in these wells; however, wells west of the south pit could be dried, depriving a ranchhouse of its present water supply.

C. CLIMATE

The impacts of the proposed mine on the microclimate would probably be localized and are quantitatively unknown. However, assuming reclamation is successful, it is anticipated that slight changes in humidity, temperature, and wind patterns would result from altering the topography and vegetation.

D. AIR QUALITY

1. Introduction

The extraction of 2 million tons of coal per year from the Pearl minesite would add possibly 6,000 tons annually of potential particulate emissions to the air,[2] thus significantly degrading the air quality of the area for a minimum of 24 years (table III-3). The increased particulate emissions are assumed to be similar to emissions from the Big Sky mine which has a similar production rate. Downwind emissions from the Pearl mine are indistinguishable from those due to the adjacent Ash Creek mine (PSO mine No. 1). Emissions would exceed State dustfall standards within 1.5 miles downwind of the minesite. Emissions would

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[2]There is a moderate degree of uncertainty in the accuracy of fugitive dust emission factors (EPA, 1979). However, these factors are the only means available to assess impacts.

TABLE III-3.--Summary of potential maximum pollutant emissions from the Pearl mine (tons/year)

Sources	Particulate	CO	NO_x	SO_2	Hydro-carbons	Alde-hydes	HCN	Organic acids
Mining (all operations)[1,2]----	6,000	42.6	3.2	---	---	---	0.2	---
Internal combustion engines								
Heavy equipment-diesel[3]-----	24.6	88.9	278.2	28.2	38.1	8.8	---	---
Coal trains-diesel[4]---------	3.0	17.5	49.6	7.6	12.6	0.8	---	0.9
Light equipment-gasoline[6]---	0.2	29.8	4.8	0.2	3.2	---	---	---
0.0002-0.4 percent coal dust loss from unit trains[6]------	4-8,000	---	---	---	---	---	---	---
Population increase[7] 462 persons 1990 estimated projection------------------	27.7	157.0	78.5	32.3	60.1	---	---	---
Total---------------------	6,060 to 14,060	335.8	414.3	68.3	114.0	9.6	0.2	0.9

[1]See appendix K for derivations.

[2]Gaseous emissions from ANFO explosives: Chaiken, R. F., E. B. Cook and T. C. Ruhe, 1974. Toxic fumes from explosives: ammonium nitrate - fuel oil mixtures. Report of investigation 7867. Pittsburgh Mining and Safety Research Center, Pittsburgh, Penn., USDI, Bureau of Mines, 24 pages.

[3]Compilation of air pollution emission factors. U.S. EPA, 2d ed. Research Triangle Park, N.C., February 1976.

[4]Eastern Powder River Coal Basin Draft Environmental Impact Statement. Table 6, p. II-40. BLM, USFS, USGS, ICC.

[5]Compilation of air pollution emission factors. Supplement #5. U.S. EPA, 2d ed. Research Triangle Park, N.C., December 1975.

[6]Paulson, and others 1976; Nimerick and Laflin, 1977. Loss of coal dust from unit trains has been insufficiently studied and is poorly understood. The amount of loss reported in the literature ranges to about 3 percent. The above was presented as the best estimate of the losses which might actually occur.

[7]National Air Monitoring Program. Air quality and emission trends, annual report, vol. 2, August 1973. EPA 450/1-73-001.

also cause a significant increase in the variability of the TSP (total suspended particulate) 24-hour concentrations and a general rise in the TSP annual geometric mean (figs. III-1, III-2). According to the regional model, calibrated after partially controlled particulate emissions--not Best Available Control Technology (BACT)[3]--at Colstrip, Montana, the standard for the annual geometric mean for TSP would be violated at least 1.5 miles downwind and the PSD (prevention of significant deterioration) increment for the annual geometric mean would be violated at least 2.5 miles downwind. Ambient sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbon concentrations, however, would not exceed Government standards. If BACT for the suppression of dust were utilized, particulate emissions would be reduced 75.8 percent, from 6,000 tons/yr to 1,458 tons/yr (table III-4). But, in order to meet ambient air quality standards, the Ash Creek mine must also control its emissions.

Primary impacts to the airshed could effect changes, or secondary impacts, in biological systems. Secondary impacts include (1) deposition of potentially toxic trace elements in overburden and coal dust on the surrounding environment; (2) minor or undetectable changes in plant community productivity and composition; (3) potential trace element toxicity to honeybees and other insects; (4) detectable increases in respiratory diseases in domestic animals; (5) possible respiratory diseases in mine personnel; and (6) a decrease in the visibility characteristics and esthetics of the area. Individual impacts would not upset the ecosystem; however, over the long term (decades or longer), combined impacts and cumulative dust from other mines could alter the biological stability and productivity of the area. (See Air Quality in the regional statement.)

Annual ambient concentrations of (TSP) could increase from twofold to eightfold with potential increases above Montana State guidelines and Federal primary and secondary standards (fig. III-1). The maximum 24-hour allowable concentrations under Montana State guidelines and Federal primary and secondary standards could also be exceeded several times annually. Figure III-2 shows the potential increase in TSP at the Pearl site on a monthly basis. The worst impacts would occur during periods of low precipitation (usually July through September). (See chapter IV, Air Quality, in the regional statement.)

The particulates emitted from the mine would originate from five main sources (table III-3). Of these, haul roads and coal handling facilities would contribute 82 percent of the particulate emissions. If adequate control technology (table III-3) were utilized on the roads and at facilities, a substantial reduction in total particulates (75.8 percent) could be realized.

Gaseous pollutants (table III-4) from mining would have less impact than TSP on air quality. There would be no violations of the air quality

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[3]BACT, for the purposes of this statement, is actually the best technology currently available, and does not take into account energy and economic costs.

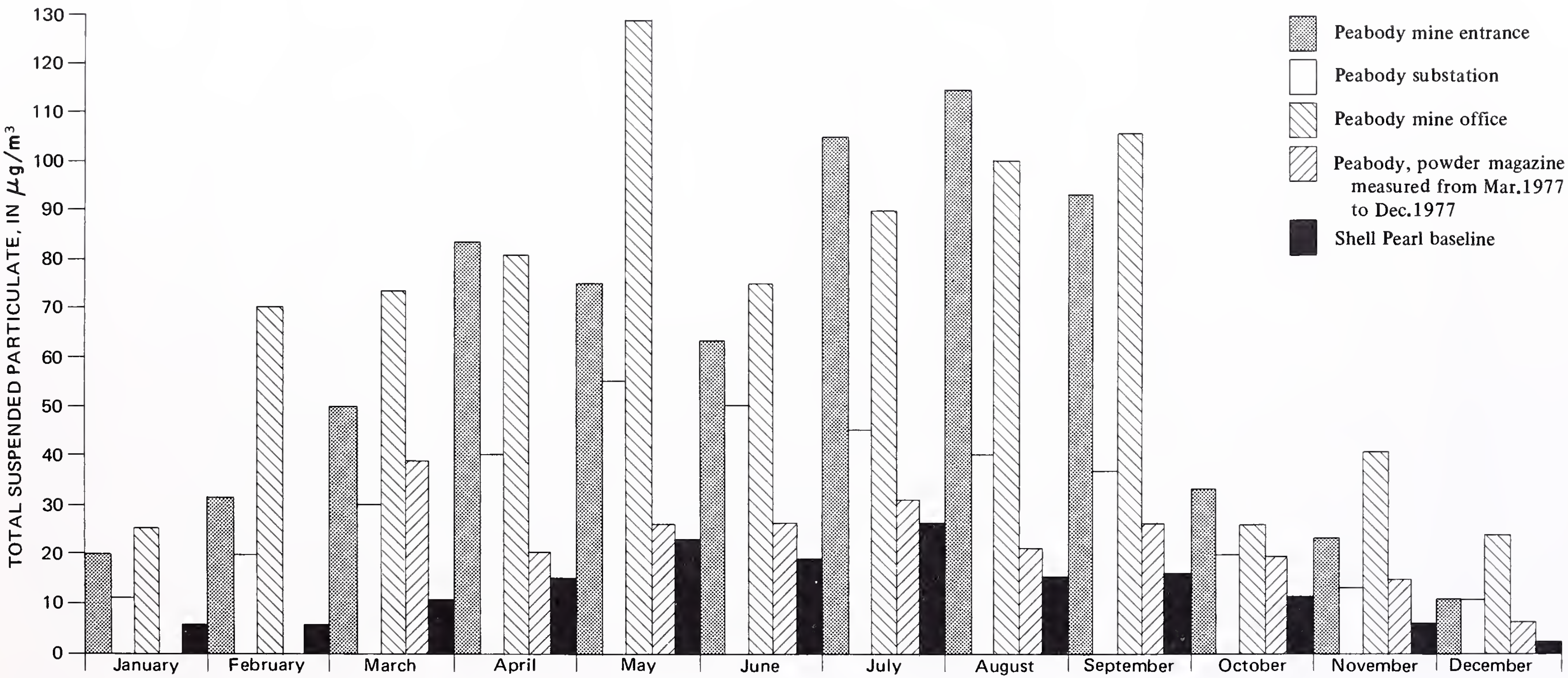

Figure III-1.—Comparison of monthly geometric means of total suspended particulate (TSP) in $\mu g/m^3$ at the Shell Pearl project site and the Peabody Big Sky mine Oct. 1975-Dec. 1977.

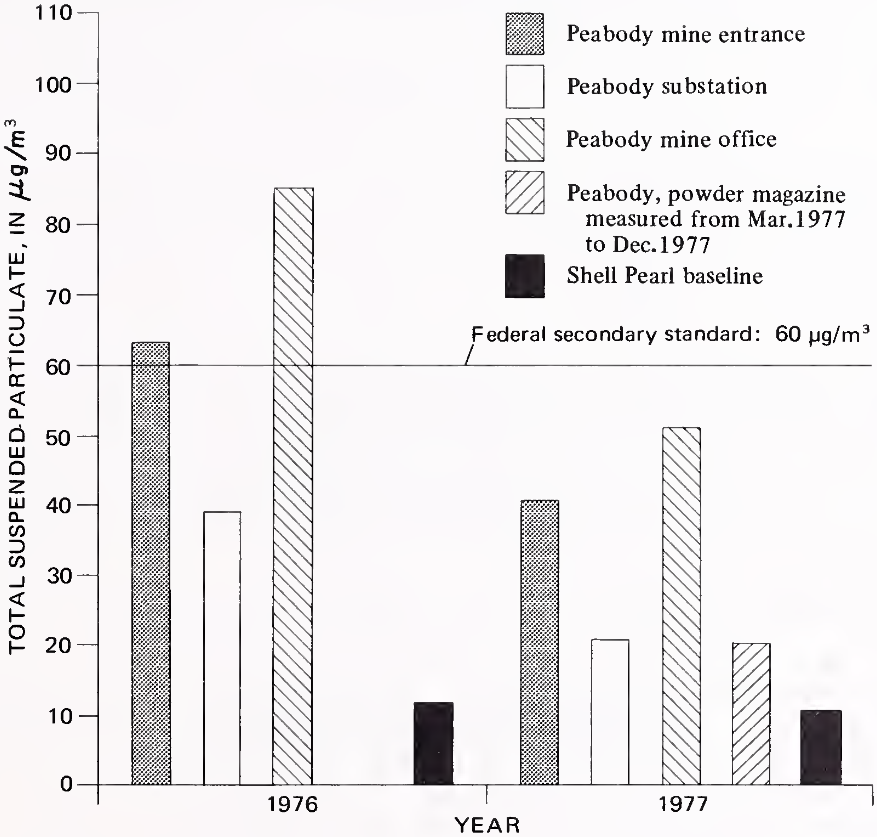

Figure III-2.—Annual geometric mean for total suspended particulate (TSP) at the Shell Pearl project site and the Peabody Big Sky mine 1976 and 1977.

TABLE III-4.--Possible reduction of particulate emissions with implementation of best available control technology at the Pearl mine

Emission source	Uncontrolled particulate emissions (tons/year)	BACT	BACT percent mitigation	Controlled particulate emissions (tons/year)
Permit area				
Overburden excavation--------	311	---	0	338
Haulage roads-------	808	0.5 gal/yd^2 twice a day.	50	404
Frontend loaders----	128	---	0	128
Graders, scrapers and tractors------	480	---	0	480
Wind erosion--------	30	---	0	30
Drills--------------	22	---	0	22
Coal crushers and conveyors-----	4,200	Enclose facilities, add baghouses, water at transfer points, negative pressure truck dump.	99.8	8
Blasting-----------	20	---	0	20
Fuel consumption----	28	---	0	28
Permit site total	6,027		75.8	1,458
Regional emission source				
Unit trains: 0.0002- to 0.4-percent coal dust loss-----------	4-8,000	Spray all coal with hot oil: 1.5-2 gal/ton.	87.5	0.5-1,000
Diesel engines----	3	---	0	3
Population increase-	36	---	0	36

standards for these pollutants. However, NO_x (nitrogen oxide) fumes and dust from blasting and coalbank fires could cause temporary but significant decreases in visibility. (See regional Air Quality.) Also, acute NO_x fumigations from blasting, in conjunction with increased particulate deposition, may harm living organisms downwind of the lease.

Coal would be transported south from the minesite via unit train. Coal dust losses from the open coal cars could total 42 tons per unit train or 8,000 tons per year. Treating coal with a binding agent during the loading operation could reduce the losses 87.5 percent or to 0.5-1,000 tons per year (Nimerick & Laflin, 1977).

The population influx associated with the Pearl mine would also impact the air quality of the region. A construction force of 200 would increase vehicular emissions and fugitive dust emissions from unpaved roads (table III-4).

2. Biological Impacts

The secondary impacts caused by deposition of particulates generated at the Pearl minesite and their significance are discussed in the regional air quality impact section. If the suggested mitigation measures are employed, the potential impacts to the surrounding biological systems could be minimized.

E. SOILS

Mining, by removal and alteration of approximately 1,217 acres[4] of soils, would significantly impact the diversity of the soils and the ecosystems based on them. After reclamation, ecosystems in the affected areas would be less stable and less diverse, creating potential long-term impacts on vegetative quantity and quality, lasting for decades. Animal populations dependent on diverse plant communities and topography would also be adversely affected. (See Vegetation and Wildlife, chapter III.) With minor exceptions, soil salvage and placement under the proposed reclamation plan is likely to maximize reclamation potential of the topsoil resource. Reclamation potential would be somewhat limited by the relatively high clay content of the soils, and the nature of the smectite clay minerals. (See Soils, chapter II.) The soils, in addition, would be subject to the unavoidable impacts common to virtually all surface-mining operations in this semiarid region. These impacts are addressed in more detail in the regional part of this impact statement.

The minor exceptions in the reclamation plan which would adversely affect the reclamation potential include a number of conditions inherent in the overburden and its proposed disposal, which could readily lead to

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[4]This figure includes an additional 19 acres dispersed around the mining, facilities, and associated disturbance areas.

reclamation problems at various times in the near future (perhaps within 5 to 10 years). For example: (1) Overburden spoils located at and near the regraded surface would have a variety of undesirable characteristics. Table III-5 shows five characteristics (clay percentage, high electrical conductivity (EC), high sodium-adsorption-ratio (SAR), and excessive extractable nickel (Ni) and molybdenum (Mo)), which could eventually (probably after 5 years) have negative influences on reclamation. (2) Material high in clay and having high SAR values would contribute to poor physical characteristics, surface erosion and piping, and movement of sodium from overburden into the topsoil. There is a high potential for adverse effects from sodium because of the dominance of smectites in the clays. Smectites are more easily affected by elevated SAR values than other clay minerals. (3) Saline spoils reduce water availability to plants by increasing osmotic potential, contributing to reduced productivity. (4) High nickel and molybdenum levels which permeate the area could result in forage unsuitable for grazing animals. Legumes,[5] particularly clover, tend to take up large quantities of molybdenum to the exclusion of copper. Cattle consuming sufficient quantities of high molybdenum forage develop molybdenosis, a copper deficiency disease (Erdman and others, 1978). If legumes are crowded out of the plant communities by the time cattle are returned for grazing, molybdenosis would probably not be a problem. Nickel may not be available in sufficient amounts to become a problem due to high pH spoils. There are insufficient data to predict plant uptake of nickel and molybdenum at the present time.

These characteristics would be prevalent in the surface and near-surface environment, because the company has chosen to rely on mixing of overburden materials, rather than selective salvage, to eliminate toxic concentrations of undesirable materials. The data in table III-5 illustrates that even if complete homogenization were achieved, problems would still exist. Because homogenization is unlikely, there would be areas of both higher and lower values than the mean values listed in table III-5. These areas would be distributed in an unpredictable pattern but would become apparent if exposed by erosion or as plants are affected when their roots extend into the material. The greatest problem area would be in the western half of the south pit where samples from test holes 7 and 8 show high clay, soluble salt, and sodium values, as well as elevated nickel and molybdenum levels.

The current mine and reclamation plan proposes to salvage the CR horizons from the Cushman and Thedalund soil series. CR horizons are relatively weathered, contain large amounts of shale and other rock fragments, and usually are more like overburden than soil. Their inclusion would raise the average depth of salvaged soil approximately 2 inches (8.8 percent) but would be offset by a decline in the quality of the reclamation surface. Inclusion of the CR horizons would yield a total of 214 acre-feet. The Cushman CR horizon would yield 24 acre-feet of comparatively benign material and increase in total salvage of 1.0 percent.

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[5] Legumes don't have to be planted to occur on a reclamation surface.

TABLE III-5.--Average characteristics for overburden and interburden underlying shallow coal seams

[Note: Values exceeding State suspect levels are double-underlined. EC values within the suspect range are single-underlined[1]]

Overburden test hole No. and depth	Percent clay	EC (mmhos/cm)	SAR	Ni (ppm)	Mo (ppm)
Northwest pit					
OB-1					
0-113 feet------	45	5.0	7.0	4.0	2.6
OB-2					
0-28 feet-------	33	0.6	1.2	0.4	2.9
46-88 feet------	52	3.6	0.6	5.0	1.7
OB-3					
0-74 feet-------	40	4.4	1.7	3.7	4.0
OB-4					
0-198 feet------	19	8.1	3.2	2.5	2.3
South pit					
OB-5					
0-26 feet-------	31	1.3	1.2	0.5	1.3
42-164 feet-----	42	3.0	1.8	3.6	1.5
OB-6					
0-122 feet------	38	2.9	7.0	3.2	4.9
OB-7					
0-28 feet-------	22	9.3	4.5	1.6	2.4
37-320 feet-----	43	3.5	25.7	2.6	4.3
OB-8					
0-274 feet------	40	3.0	17.7	2.9	4.3

[1]State guidelines suggest the following suspect levels:

Clay------ 40 percent
EC-------- 4-6 mmhos/cm
SAR------- 12
Ni-------- 1ppm (DTPA extractable)
Mo-------- 0.3 ppm (ammonium oxilate extractable)

The Thedalund CR would contribute 190 acre-feet, an increase of 8 percent. Based on the sample analysis provided by the company, this material is clay in texture, has a very unfavorable calcium to magnesium ratio (0.26:1), and consists primarily of soft platy shale, with some interbedded sandstone.

The mine and reclamation plan also suggests the possibility of salvaging the Midway series to a depth of 18 inches if the soil volume is required for subsoil material. Because of the clayey (montmorillonitic, smectitic) and rocky (average: 30 percent) characteristics of this soil, it is unsuited for this use.

Several other proposed aspects of the mine and reclamation plan should be studied further prior to approval. These include: (1) Storage piles and overburden spoil would be mulched with clean straw for wind erosion control, when "topsoiling" is delayed. This would leave 25-50 percent of the surface exposed within the mulched area. Such a treatment does not address the potentially greater problem of raindrop impact, which would displace soil material and cause crusting, reduced permeability, and increased runoff and erosion (Baver, Gardner, and Gardner, 1972); (2) Coarser textured topsoil could be placed on steeper convex slopes, and finer, more clayey topsoil in lower, more level positions. Placing coarse topsoil over fine overburden spoils on slopes could promote piping, although deep chiseling of overburden might reduce the probability. Observations at existing mines indicate that overburden spoils remain impermeable even after ripping. Sandy loams and loamy sands (Alice, Chugter, and Cushman soils) would be highly erosive and not suitable for placement on convex slopes. (3) Topsoil from all disturbed areas could be salvaged and stored until needed. Topsoil in the overburden storage area (225 acres), from the initial boxcut (58 acres), and from much of the facilities area (perhaps 80 acres) would be stored more than 20 years at a depth of up to 60 feet. This would have an impact of unknown dimensions on soil organisms, chemical equilibrium, and subsequent reclamation success, (4) The county road which crosses the south pit area to the east and north of the pit area would be relocated. The proposed location is primarily on alluvial soil series, including the Haverson, Heldt, Korchea (water table) and Lohmiller, which are managed for hay production and improved pasture. The relocation as proposed would permanently remove soils having agricultural potential (currently IIIe, see appendix E) from production, and would create numerous small fields which would be more expensive and time consuming to manage. Flood irrigation, now practiced on 15 to 20 acres, could become impractical, (5) Irrigated lands in the area affected by the road would require special salvage and reclamation practices if these areas meet the criteria for prime farmland.

F. VEGETATION

If reclamation is successful in the long term, the destruction of the vegetation mosaic and species diversity on the Pearl area would not be significant. In the short term, however, there would be a significant decrease in the species diversity. Additionally, in the short term, the

vegetative loss would increase erosion (slightly), decrease the area's esthetic value, disperse wildlife to adjacent areas, thus overloading the carrying capacity, and would create a net loss of an estimated 2,100 AUM's of livestock forage out of production. Reclamation success is dependent on soil conditions, and if it were to be unsuccessful, the impacts could become significant in both the short and the long term.

The proposed seeding mixture (table I-5) contains approximately 10 percent of the number of species occurring prior to mining.[6] The five different seed mixtures proposed by Shell, to accomodate different sites, soils, and uses, are acceptable, given the species commercially available. The total rates of application are greater than those sometimes recommended (Cook and others, 1974). However, experience in the northern Powder River basin has indicated that such rates are not excessive (DSL). This is due in part to the fact that not all seed planted will become established, regardless of germination percentages and pure live seed requirements.

Although some species may cause problems for livestock, or unnecessarily complicate the mixture (BLM, 1979), these species help increase the diversity (a legal requirement)[7] and are part of the existing environment. Examples of this include wheatgrasses and needle-and-thread grass.

It is considered necessary to have both western and thickspike wheatgrasses in the seed mixture, although they are ecologically similar and provide nearly the same degree of success. Planting only one species would defeat the ecological purposes of the diversity requirements and not meet the requirements of the law.

Ripe seeds of needle-and-thread grass cause problems (BLM) on overgrazed sites for those cattle ingesting seed. In the spring and fall (before and after seed set), however, this is a highly palatable and preferred forage. For this reason, and because of legal requirements, needle-and-thread grass should be retained in the seed mixture.

Seeds of some species, because of their shape and/or size, are difficult to drill mechanically. However the advantages of using a diverse mixture, as a step in attaining successful reclamation, would far outweigh the disadvantages of calibrating the seed drill. Alternatives are presented in chapter VIII.

For the first decade or so after reseeding, the reclaimed areas would have a relatively uniform composition of grasses, forbs, and weedy species, creating a thin canopy cover. This would allow for increased

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[6] Only about 10 percent of the existing species in the area are available from commercial seed sources.

[7] Surface Mining Control and Reclamation Act of 1977, P.L. 95-87, sec. 519 (b); Montana Strip and Underground Mine Reclamation Act of 1973.

erosion rates which would decrease towards normal as the canopy cover and litter layer (dead leaves, etc.) developed. (See Soils, Geology.) Postmining livestock carrying capacity may range from 50-percent less to 50-percent more than at present.

Diverse vegetative patterns would probably begin to appear within a decade or two after reseeding. However, until heterogeneity is reestablished, wildlife use and capacity would be lower than premining levels. (See Wildlife.) A number of trees and shrubs, particularly those requiring specialized micro-environments and soil types, would be lost from the reclaimed surfaces for the long term, unless reclamation technology improves substantially. If the alluvial aquifer in Little Youngs Creek were not successfully restored, the reestablishment of deciduous trees requiring a shallow water table may be permanently precluded. Species such as riparian shrubs would be lost for perhaps several decades. Consequently wildlife use would be lower than premining levels.

No threatened or endangered plant species grow in the area.

The regional part of this statement further addressess impacts to vegetation which are common to all mines in the northern Powder River basin.

G. WILDLIFE

About 1,196 acres of habitat essential to wildlife would be disturbed or destroyed, for at least several decades for some species and perhaps longer for others. Animals would disperse to adjacent areas where they could find suitable alternative habitat, but in so doing they would overload the area's carrying capacity, until equilibrium were reached. This would be particularly true of big game, such as mule deer, and of upland game birds, such as sharp-tailed grouse.

New roads combined with increased employment at the mine would increase disturbance to wildlife by off-road-vehicle traffic and hunting pressure (legal and illegal). Vehicle/animal collisions would probably increase to an unknown extent. Railroad traffic to the Pearl area would increase the potential for train-animal collisions.

Reclaimed surfaces, to date, appear to be merely a soil-stabilizing vegetative cover. Although establishment of a moderately diverse grass cover could be attained, successful establishment of self-sustaining shrubs and ponderosa pines on mine reclamation areas has not yet been demonstrated to date in the northern Powder River basin due to limited (10 years) of experience. Consequently, species dependent upon pine and shrub habitat types (mule deer, antelope, sharp-tailed grouse, etc.) could be largely precluded from reclamation areas until those types can be reestablished. Complete reclamation of shrub and ponderosa pine habitats may be quite long term, if possible at all.

1. Mule Deer

Mining would reduce the local mule deer population by both displacing animals to adjacent areas and depressing the reproductive rate, until equilibrium is reached. The degree of reduction cannot be quantified. Mining would not directly encroach upon important winter ranges but would likely restrict effective range size by displacing deer at least out of visual contact with the mine and support facilities. In addition, the rail spur would bisect two winter ranges.

The northwest pit, spoils piles, and haul roads (about 450 acres) would eliminate a significant amount of prime mule deer habitat. Ponderosa pine habitat and broken topography, which provide primary, year-round security cover for mule deer and other wildlife species, would be reduced or lost altogether.

Mining would interfere with mule deer use of Little Youngs Creek, where riparian habitat may be important as a winter use area and a key fawning site for local mule deer. According to O'Gara (oral communication, 1977), subirrigated bottomlands provide succulent, protein-rich forage that is important to pregnant deer during late fetal development and post-natal lactation. Mining will directly conflict with mule deer use of the creek for a distance of about 1 mile, where the south pit and rail spur intercept the creek. This restriction of use could depress mule deer reproduction. Mining and related activities could also disrupt seasonal movements through the area, especially those along Youngs and Little Youngs Creeks in spring and summer.

2. Antelope

Mining, support facilities, and spoils piles would virtually preclude antelope use from the western half of the permit area, which appears to be a spring and summer range. Mining would likely interfere with winter use of the Pearl permit area and, thus, would concentrate antelope on adjacent winter range (fig. II-12). To the south, the rail spur bisects a portion of two important winter ranges. During periods of deep snow, antelope-train collisions would increase. Movements within the winter ranges would be periodically interrupted by rail traffic, with the most severe effect being a possible shift of animals to other wintering areas, which probably are at capacity (e.g., the Spring Creek and Decker areas). If those areas are at or near carrying capacity, competition for food, space, etc. could result in antelope losses. Loss of the Youngs Creek winter range could result in substantial reduction of a herd of up to 100 antelope during a winter comparable to that of 1977-78. The cumulative impact of Pearl and future mines projected in the drainage would potentially destroy the existing Youngs Creek winter range. (See chapter IV, Wildlife, regional statement.)

Antelope may be sensitive to disturbance at or near natal sites because does tend to isolate themselves about a week prior to fawning. Mining might, therefore, interrupt antelope fawning. Consequently, some

reduction in local antelope reproduction could result, the degree dependent upon the significance of the Pearl area as a natal site.

Antelope concentrate more outside the Pearl lease area than within. Presumably antelope transect the lease area during seasonal movements. Mining on the Pearl area might interfere with antelope movements by blocking preferred routes and restricting distribution.

The failure of reclamation efforts to restore habitat types necessary to antelope (sagebrush) would be an adverse impact similar to that imposed on mule deer.

3. White-tailed Deer

Mining would disturb an estimated 100 acres or more of riparian habitat along Little Youngs Creek, and possibly Youngs Creek, and therefore would decrease the use of these drainages by white-tailed deer. Displacement of deer through decreased space and cover, and increased competition for food would compound the apparent and unexplained decline of white-tailed deer in the area over the past 3 to 5 years.

4. Other Mammals

Substantial small mammal habitat (perhaps 800 acres) would be lost as a result of coal development on the Pearl area. Substantial (but unquantifiable) numbers of animals would be directly eliminated during mining because of their limited mobility. This loss would reduce the prey base and, thus, reduce the populations of predatory species (mammals, birds and reptiles). (See fig. II-13.)

Mining and related developments would eliminate an undetermined quantity of shrub/grassland/rock outcrop associations comprising prime cottontail habitats. As a result, population levels of cottontails on the Pearl lease would be lowered to an unknown degree.

Mining would not affect the prairie dog town on the Pearl permit area.

Habitats of water-oriented mammals (muskrats, raccoons, and mink) would be directly disrupted by mining for about one-half mile along Little Youngs Creek but would be only slightly affected by facilities developments. A rail spur and a powerline scheduled to cross Little Youngs Creek would also directly affect riparian habitats. Contamination of Youngs and Little Youngs Creeks from mine effluents and the rail crossing may threaten water-oriented species. Proposed water-control developments are designed to prevent degradation of water quality in both drainages from either facilities or pit water.

5. Raptors

Birds of prey (raptors) would be adversely affected by disruption of nesting sites and hunting areas, and reduction of prey populations.

Reduction in numbers of cottontails would probably diminish use of the Pearl area by golden eagles, red-tailed hawks, prairie falcons, and great horned owls. Loss of preferred cottontail habitat is irretrievable with current reclamation technology. Therefore, cottontail populations would not likely be returned to premining levels. Consequently, the larger raptors, which generally hunt for larger animals, would be impacted for a much longer period than small raptors. Smaller raptors, such as the American kestrel, would be affected by reduced populations of small rodents (deer mice, for example). Deer mice have responded well to mining reclamation, with initially high densities followed by a reduction to relatively stable populations (ECON, 1976a).

One red-tailed hawk nest, two great horned owl nests, one known kestrel nest, and one long-eared owl nest would be destroyed. Furthermore, several acres of ponderosa pine would be lost, which provide potential nesting sites for these birds as well as for golden eagles. Some potential raptor nest sites adjacent to the Pearl lease area might also be precluded by mining.

Three active golden eagle nests within 1.5 miles southwest of the mine pit and two prairie falcon nests along the east boundary of the Pearl area may be disrupted by mining (fig. II-14). Disturbance of prairie falcon nesting in southeastern Montana can be critical, first of all, because nesting sites are limited; second, because breeding success may be declining in the area; and third, because the prairie falcon has been previously listed as a threatened species. Disturbance may result in egg loss, because the female incubates in a poorly defined nest, with her legs tucked under her and if provoked to rise suddenly, she scatters eggs as she pushes off (Snow, 1974). Disturbance may also cause nest abandonment, particularly during the incubation period.

6. Upland Game Birds

Sharp-tailed grouse populations and production in the Pearl vicinity could likely be depressed by mining, but the magnitude cannot be determined. One lek would be enclosed by the rail loop. Disturbance may disrupt sharptail use within one-quarter mile of the areas of mining.

Breeding activity of sharptails could be interrupted and possibly eliminated. Displaced breeding birds may reestablish a new lek, join adjacent leks, or be lost as a local breeding population. Immigration to an adjacent lek is possible; the nearest lek is less than 1.5 miles west of the permit area. If recruitment into another breeding group does occur, increased competition among adult males may interfere with breeding activities, thereby diminishing production. Failure to reestablish a new lek or join adjacent breeding groups means that the Pearl breeding population would be ultimately eliminated because breeding activity and increment of the young would cease.

Mining development would virtually eliminate the western half and perhaps all of the Pearl permit area for use by sage grouse. There are

no known sage grouse leks on the Pearl permit area; however, three are within 2 miles (fig. II-13). If disruption of these leks occurs, adjacent leks could be affected by immigration of displaced birds. Breeding behavior could be interrupted and the disorganization could increase the vulnerability of resident grouse to predation; consequently the population would decline. However, lack of information precludes verification and quantitative prediction of such declines.

Turkey population on the Pearl area probably would be reduced and possibly eliminated, especially along Little Youngs Creek.

Wintering ring-necked pheasant on Little Youngs Creek within the permit area would be adversely affected. Mining would likely displace current concentrations of pheasant and possibly preclude their use of that habitat for the life of the mine. Displaced birds might be highly vulnerable to predation, and accrual into other concentrations (possibly along the Tongue River) might depress the productivity and population density by increasing competition for food, cover, space, and breeding territories.

Hungarian partridge would likely be discouraged from winter use of the area along Youngs Creek at the northern boundary of the lease. Partridge may relocate to other suitable areas up-drainage and negate the adverse impact.

Impacts to waterfowl would likely be minimal because there probably would be minor or no disruption of aquatic habitats. Settling ponds for mine effluent and drainage diversion might benefit waterfowl.

7. Songbirds

Songbird-species diversity and population levels would be greatly reduced by loss of ponderosa pine and sagebrush/grassland habitats. The preliminary nature of baseline information regarding songbirds precludes an extensive evaluation of impacts.

8. Reptiles and Amphibians

Prairie rattlesnakes would be adversely affected by the loss and doubtful reclaimability of significant amounts of prime habitat (rock outcrops associated with big sagebrush/grasslands). Aquatic reptiles and amphibians could be adversely affected if there were pollution of Youngs and Little Youngs Creeks by mine effluents and sedimentation.

9. Fisheries

There are no fisheries on the permit area, and little or no impact would occur to the limited fishery in Youngs Creek.

10. Endangered species

There are no known threatened or endangered species within the permit area. The prairie dog town on the Pearl area (fig. II-13) is potential habitat for black-footed ferrets; however, no evidence of black-footed ferrets has been observed (Farmer, 1977). Mining encroachment would be no closer than one-quarter mile from the prairie dog town. Thus, no adverse impacts on threatened or endangered species are expected.

H. SOCIOLOGY

1. Population

With the opening of the proposed Pearl mine, the population in Sheridan County would be expected to increase by approximately 460 persons by 1990, and the population of Big Horn County would remain relatively unaffected (appendix L). The impact would be totally different if several other mines opened and/or a new town were built in the Decker area simultaneous to the opening of the Pearl mine, as described in chapter IV of the regional part of this statement.

2. Social Impacts

Although the social impacts of the Pearl mine alone to Sheridan County (about 6 percent of the projected total) would not be of great significance they are an additional stress on an impacted community. The aggregate effect of ongoing mining activity, and the addition of the Pearl mine to this activity, is a significant change in the way-of-life of many people in the area. Population projections indicate the rapid growth of Sheridan to about 22,400 people, a size at which individuals would no longer see each other as individual persons; there would also be an increasing dependence on formal social agencies (e.g., police, schools) to control social problems (Meadowlark, 1978). There would be a further decline in the social and psychological well-being of persons living in the area because the population increases associated with the Pearl mine would further strain services of all types.

The Pearl mine is unlikely to have a significant social impact in the Decker-Birney area unless many Pearl miners settle in a new town in the Decker area (were it to be developed). This settlement pattern may be unlikely because Sheridan is closer, by road, to the minesite than is Decker and because the services available (e.g., shopping, libraries, doctors, etc.) in Sheridan far exceed, in quantity and quality, those that would be available in a new town. However, the combined effect of Wyoming and Montana taxes may induce many of the Pearl miners to settle in a new town.

A more thorough discussion of population changes and sociology is available in the regional part of this statement.

I. ECONOMICS

Mining at the Pearl site would change the present and future economic environment of nearby areas within Montana and Wyoming. Employment, population, income, and the need for public goods would increase. Indirect effects, such as need for housing, and additional private goods and services would occur. These changes would be similar to those existing and projected changes caused by coal development.

The relatively rapid growth rate in the area is probably causing prices to increase faster than in other parts of the northern Great Plains (Temple, 1978; Wyoming Department of Administration and Fiscal Control, 1979). The general economic impacts are discussed in greater detail in chapter IV of the regional statement.

1. Employment

There would be approximately 250 more jobs in the area as a result of the Pearl mine (appendix L). Most of these jobs (136) would be as operational employees of the mine. Only 112 permanent jobs in the ancillary sector are projected. Shipment of coal by rail would create additional jobs both in the region and all along the route to consumers. The construction of the mine would provide temporary employment for between 213 and 255 persons for 2 years. Unless a new town develops in southern Big Horn County, all ancillary jobs will be located in and around the city of Sheridan, thus employment in Big Horn County would not be affected. (The effects of the new town are discussed in the regional statement.)

2. Income

The most noticeable income effects will occur in Sheridan County. At current wage levels the mine's annual payroll would be $2.9 million and the ancillary employment will have a payroll of about $790,000 a year, resulting in a total annual personal income increases of about $3.7 million. During the construction phase, the mine would increase local personal income by nearly $4.6 million a year. There is no empirical evidence that the development of nearby coal resources has caused greater than normal increases in wage levels for the region's ancillary wage sector, and so no effect on the prevailing wage rate in Sheridan and Big Horn counties is projected.

3. Fiscal Conditions

The Pearl mine, because of its relatively small work force and resulting population increase, would not have a major effect upon the future fiscal conditions in Sheridan County. The most noticeable difference in the pattern of development is the slight amelioration of the county's existing problem of its need for revenue growing at a faster rate than its sources of revenue. (See appendix M.) Most of the difference is not a result of the inclusion of the Pearl mine, but rather a residual result of

the large increase in revenue in 1979 which is a result of a 33 percent increase in the sales tax rate that went into effect in December 1978. Similarly, neither the city of Sheridan nor the local school districts would experience major changes in their revenue and expenditure trends.

The minesite is located in a school district which has and will continue to have a tax rate (mill levy) that is near the statutory minimum. The addition of the taxable value represented by the mine will not, therefore, have a significant effect upon the school district's tax rate. The State School Foundation Program will be the primary beneficiary of the taxes for educational purposes paid by the mine.

The primary fiscal effect on Big Horn County would be an incremental increase in its taxable value in 1982, when the Pearl mine goes into production (see appendix M), followed by a return to baseline growth conditions. This increase, primarily because of the increase in valuation of the county's gross proceeds property, would result in an increased ability to finance short-term, i.e., annually funded, county services. Since this site specific does not assume a new town in southern Big Horn County, almost all of the population increase, and hence the need for county-level services, would occur in Sheridan County. On net, Big Horn County would be in a more advantageous fiscal position with the Pearl mine than without.

However, the increases in the county's taxable value that the mine would provide, will also significantly increase the percentage of taxable value that is coal related. By 1983 more than three-quarters of the county's tax base will be directly dependent upon coal production, and thereby be subject to risk of extreme fluctuation caused by forces outside its influence. Such forces include: Change in State or Federal environmental or other standards which could cause a shift in the location of mining away from Big Horn County; work stoppages at the mine, in the transportation system, or at the utility; or severe weather conditions (such as experienced this past winter), which result in a disruption in the delivery system, thus restricting the planned output of the mine. Uncertainty in countywide taxable value should cause long-term municiple bond buyers to demand, and probably receive, a higher interest rate, thus raising the cost of locally-financed municiple facilities. The higher cost of long-term financing should cause a shift in the county's debt preference away from long-term general obligation bonds. Facilities financed over a shorter period would require fewer total mills, but a higher annual mill levy. Facilities that ordinarily would be funded through long-term financing would become more likely to be deferred or abandoned.

J. COMMUNITY SERVICES

Pressure on community services is and would be a further problem. Water/sewer, police protection, medical facility, and service needs, as well as needs for social and mental services would be a continuing problem in Sheridan County because much of the tax generation from the Pearl mine

would be distributed to the State of Montana and Big Horn County and not in Sheridan County where the negative fiscal impacts would occur.

Because Federal financial aid usually is not available until after fiscal impacts are felt, needed public facilities in Sheridan may not be funded in a timely manner.

More detail on the impacts to community services is given in the regional part of this statement.

K. LAND USE IMPACTS

Conversion of approximately 3 square miles of a largely natural rural landscape to an industrial (strip mine) complex would constitute the major impact to land use. Secondarily, the change in habitat types and vegetative communities would reduce the quality of wildlife habitat, grazing, and watershed cover. (See chapter IV, regional statement.)

The land use impacts generated by the Pearl mine are part of much larger changes resulting from coal mining, collectively, in Sheridan and Big Horn Counties.

1. Local Impacts

The 1,462 acres within the permit application area would be diverted from present livestock grazing, wildlife, and watershed use. Of this, about 1,196 acres would be disrupted for mine pits and facilities, and eventually would be reshaped and revegetated. The proposed rail spur from the minesite (Montana-Wyoming border) to the junction with the Decker rail line is approximately 12 miles in length. Assuming a 200-foot right-of-way, this would convert an additional 291 acres of land in Wyoming to mine transportation use.

The approximate acreage of lands committed to the various types of mine use is shown in table III-6.

TABLE III-6.-- Lands committed during the 27 years of mining and reclamation

	Acres
Mining facilities --------------------	260
Mine pit------------------------------	616
Stockpiles (soil and overburden)------	300
Road relocation and railroad----------	20
Associated disturbance (not directly altered)--------------	266
Total---------------	1,462

As reclamation of the mined-over area progresses, the land would be returned to premining uses of grazing, wildlife habitat, and hay production. The restoration and seeding of the mined area should be completed 27 years after mining begins (chapter I).

Present forage production on the permit area is estimated to be about 330 animal unit months (AUM's) per year. (See Vegetation, chapter II.) The construction phase of development would remove about 350 acres from forage production (approximately 58 AUM's), and in the first year of mining another 58 acres (10 AUM's) would be removed. Over the 20 years of active mine development an average of 30 acres (5 AUM's) would be removed from production each year. After bond release, a minimum of 10 years, the reclaimed pit areas would revert to grazing lands.

No current cropland would be impacted by the mine; however, approximately 280 acres of soils on the site have the potential for crop use under appropriate management. Of these lands, 136 acres (48 percent) are considered potentially irrigable. (See Soils, chapter II.)

Most of the 291 acres in Wyoming, used by the rail spur, would be retired from grazing use. About 1 mile of the proposed 15-mile route crosses lands now used for crop production[8] and would impact an estimated 24 acres of cropland. If adjacent coal is developed, particularly on the Crow Indian Reservation, the commitment of land to the rail spur would extend well beyond the life of the Pearl mine.

Exploration and development on oil and gas leases within the permit area may be delayed by the Pearl mine development. (See fig. I-6.) Whether or not such conflict would arise cannot be predicted with any certainty although the Ash Creek oil field has producing wells 2 or 3 miles to the west and wells in the Ash Creek South field are within 3 miles to the southwest. In any case, mining activity would not permanently prevent oil and gas exploration, but access to a specific site may be delayed months or years during the cycle of mining and reclamation. Impacts on potential development of oil and gas from the construction of the rail spur should be negligible since the right-of-way is sufficiently narrow to provide no serious hindrance to testing or developing any particular oil or gas structure.

Approximately 3.8 miles of county road would be rebuilt east of the south pit (fig. I-8). The lines of the Range Telephone Cooperative and the Sheridan-Johnson REA would be relocated along this new road.

No other rights-of-way or special use permits exist to be impacted within the permit area.

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[8]Estimated from air photos in USDA, ASCS files Sheridan.

2. Regional Impacts

The Pearl mine is forecast to induce the migration of 462 people into the region by 1990 (see Population, chapter III), and, given present residential and transportation patterns, these people could be expected to reside in Sheridan County. Assuming an average family size of 2.8, the Pearl mine would create a demand for 165 additional dwelling units by 1990. Using the 1977 Sheridan County ratio of new conventional homes to new mobile homes, the Pearl mine would create a need for construction of 113 conventional homes and location of 52 mobile homes by 1990.

Because the city of Sheridan is the most developed, the largest proportion of the influx of new workers is expected to reside there. A number of conditions suggest that other communities, most notably Ranchester and Dayton, would bear a considerable share of the impact. These conditions include: the availability of housing in Sheridan, transportation linkages which facilitate access to Ranchester-Dayton, and receptivity to growth in the various communities.

Based upon current growth patterns, it is assumed that, if all of the population growth occurs in Sheridan County, each of the three incorporated municipalities would receive the following proportions of the mine population: Sheridan, 50.6 percent; Ranchester,11.2 percent; Dayton, 4.7 percent.[9] Some of the new workers would seek residences in unincorporated places, rural trailer courts, or on individual rural acreages. Distribution of demand is difficult to predict at this time, since it depends not only upon individual worker's preference but also upon separate decisions by local governments, private developers, and land owners.

In Sheridan, each existing housing unit required an estimated average of 0.16 acres of land.[10] Ranchester and Dayton, with less restricted space and few multifamily units, average 0.3 acre/residence while an estimated 0.5 acre is required by residences in rural and unincorporated places. Using this distribution of new residents, the Pearl mine may result in the conversion of approximately 49 acres of land to residential uses (table III-7).

Commercial sites and other land uses of an urban character would increase in proportion to residential land development. As population increases more land would be needed for telephone and electric service rights-of-way, water and sewer service where concentrated growth occurs, upgrading of existing roads, and construction of new roads.

Regional impacts on agricultural, recreational and wildlife land uses are treated under these headings in this chapter.

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[9]This distribution could be significantly different if a new town is developed nearby in Big Horn County.

[10]Sheridan Area Planning Agency, Housing Survey, 1976.

TABLE III-7.--Estimate of residential land required by the Pearl mine

Probable location	Share of total (percent)	Number of units	Average acreage/unit (acres)	Acreage required (acres)
Sheridan------	50.6	84	0.16	13
Ranchester----	11.2	18	.30	6
Dayton--------	4.7	8	.30	2
Rural and unincorporated places[1]-----	33.5	55	.50	28
Totals-----	100.0	165	---	49

[1]Some new residents may locate as far afield as Buffalo, Wyoming or towns along US Route 87 in Montana, rather than in rural Sheridan County, in which case their average lot size would be less than this estimate. Further, these statistics are developed to suggest the general magnitude of residential land needs, and not as a specific prediction.

3. Cumulative Land Use Impacts

The 1,462 acres encompassed in the Pearl application would be added to approximately 10,100 acres contained in the 3 existing mines in the vicinity (southern Big Horn County, Montana, and northern Sheridan County, Wyoming).[11] Other projected mines are expected to add about 10,578 more acres to this mining area in the next few years.[12] A discussion of projected developments and their cumulative impacts are discussed in chapter IV of the regional part of this statement.

The Pearl mine would contribute to pressures for the creation of one or more new towns in Big Horn County. Prospects for new town development are discussed in chapter VIII of the regional statement.

L. TRANSPORTATION

Increased highway traffic would result from the opening of the proposed Pearl mine. Motorists would experience delays and increased

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[11]The Ash Creek, Big Horn, and Decker mines.
[12]Decker North Extension, Spring Creek, and Consolidation Coal Co. C-X Ranch.

accident hazards as a result of rail spur construction, and grade crossings. Increased traffic would result in increased accident rates, system deterioration, increased maintenance costs, and lowered system efficiency, if not mitigated.

1. Local and Regional Impacts

a. Highways

Traffic on roads serving the Pearl mine would increase as construction and mining activities develop. The main increase would be on the county road from the mine to its junction with Federal Aid Secondary (FAS) Route 338 on Ash Creek. Most mine traffic on route 338 would be oriented south toward Sheridan and Interstate 90. The county road serving the mine area should adequately handle the expected traffic increase; however, more frequent blading would be necessary and dust may become a problem in dry weather. In time, users would probably pressure Sheridan County to provide hard surfacing as far as the State line. Approximately 3.8 miles of new county road would be built by Shell Oil Co. to replace the segment across the proposed south mine pit. This new segment would also provide access close to the mine facilities site.

Traffic impacts would fluctuate as the number of workers varies. Construction would require 205 workers the first year and 257 the second year. Total onsite workers would be 116 during the first year of mining and 136 thereafter through the remaining 24 years of active mining (chapter I). Workers residing in Ranchester (11 percent) and Dayton (5 percent) would probably urge the county to upgrade existing roads between Ranchester and the Ash Creek road to shorten and improve access to the worksite. The impact of increased traffic on highways other than FAS 338 and the adjacent county roads would be modest and generally diffuse.

Increased road use would accelerate deterioration and increase maintenance costs and probably would increase accident rates. Increased traffic may force improvements of county roads at public cost. Until such improvements were made, local users of these roads would be inconvenienced by the heavier traffic and probable construction activities.

Increased traffic delays would occur at any railroad grade crossings. Details of the rail spur design have not been submitted, but there would be a potential grade crossing of the county road about 2 miles south of the mine and one or more county road crossings near Beatty Creek east of the Tongue River. Another would cross the county road on Prairie Dog Creek west of the junction of the Pearl spur with the existing Decker spur. A second potential crossing of the county road between FAS 338 and the mine would cross at an elevation well above the existing road. The expected crossing of FAS 338 would also require grade separation.

A number of dirt roads leading to fields or ranch facilities would also be crossed by the proposed spur.

Unit trains moving to and from the mine would block each grade crossing an estimated 44 minutes per week.[13] Equipment malfunctions could occasionally cause more extended delays (Montana Highway Department Public Hearing, December 1976). These delays would inconvenience local ranchers and other residents, mine workers, school buses, mail and other deliveries, and--perhaps most seriously--emergency vehicles to Sheridan. There would be an increased potential for car-railroad accidents at grade crossings.

b. Railroads

The major impact of the Pearl mine upon the local and regional rail system would be the addition of about 15 miles of spur line plus mine trackage and hauling of about 200 unit-train loads of coal each year for 20 years. Considering back haul, this means 400 point-to-point train movements annually.

This mine project would occur at a time when coal shipments are expanding nationwide. It would add to the demand for new coal cars, motive power, and rail personnel for maintenance of equipment and right-of-way.

All coal trains from the Pearl mine would join the Burlington Northern mainline east of Sheridan near Wyarno (fig. II-16). Routing of the coal from this point is not known at this time because markets have not been identified.

2. Cumulative Impacts

Coal produced at Pearl would travel over tracks also serving other local and regional mines and other rail users. Pearl traffic would add to impacts from existing or soon to be initiated traffic in this general area. Locally, Pearl traffic would be added to the traffic from the existing Big Horn and Decker mines and the proposed Spring Creek mine further north. Table III-8 shows the potential weekly train movements to and from mines in the immediate area.

The potential full production traffic without Pearl would be about 126 train movements weekly. Pearl would increase this traffic by approximately 6 percent.

M. RECREATION

1. Onsite Impacts

Fencing and excavation of the proposed mine would remove approximately 1,462 acres of potential recreation area for the life of the mine. Impacts

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[13]Based on four trainloads/week (8 one-way movements) and an average blocking time of 5.5 minutes at a crossing with each train movement.

TABLE III-8.--Expected weekly train movements to and from mines in the immediate area

Source of traffic	Average number of trains/week[1]
West Decker mine	38.4
East Decker mine	25.8
North Decker mine[2]	8.8
Spring Creek mine[2]	38.4
Big Horn mine	11.5
Ash Creek mine[2]	3.1
Subtotal	126.0
Pearl mine[2]	7.7
Total	133.7

[1]Includes loaded outgoing and empty returning trains.
[2]Mines not yet in production.

on recreational use within the mining area would be minor based on existing use levels and private ownership. Secondary impacts would be increased use of nearby public and private lands and existing recreation facilities. The significance of the increased use would be the change in perceived levels of quality of the recreation, rather than the available opportunity.

2. Offsite Impacts

These impacts are described in chapter III of the regional statement.

N. CULTURAL RESOURCES

There will be no adverse impacts to known cultural resources within the bonded area. Only two sites of significance are located in the mining area. One (Bunny Chase 24BH1574) has had data collected under a "no adverse effect" ruling from the Advisory Council on Historic Preservation. These data have been evaluated and a final report is forthcoming.

The second site (Devastation Shelter 24BH1505) is located outside of any planned mining activity. This site is currently being considered for eligibility for nomination to the National Register of Historic Places. Should it be determined eligible, plans will be made to protect it from vandalism or other disturbance related to mining activities.

According to Gregg (1977) and Western Interpretive Services (1976) no identified historical sites of any significance are located within the mine area. No significant impacts would be noted.

Impacts to cultural resources from mining are described in greater detail in the regional statement.

O. ESTHETICS

Esthetic qualities on the 1,462-acre permit area would change markedly from a rural to an industrial setting for the life of the mine. Following reclamation the site would be returned to a more natural state; however, it would never be returned to its premining appearance.

The noise and odors due to mining activity would increase and the slow, quiet motions of nature would be replaced by moving equipment, haul trucks, trains, and personnel carriers. This, however, would last only for the life of the mine, unless new mining were begun adjacent to the Pearl site.

CHAPTER IV

MITIGATING MEASURES

Measures that would be employed to mitigate adverse impacts of mining are (1) those measures proposed by the company as a part of the mining and reclamation plan (if the plan is approved, the measures are binding on the company); (2) those measures required to meet the standards required by various State and Federal laws and regulations, the principal agencies being outlined on page I-4; and (3) additional requirements or stipulations that could be imposed at the discretion of the Office of Surface Mining, the Commissioner of the Montana Department of State Lands, or other Federal or State agencies which have permit authority (such requirements must be reasonable, noncapricious, and enforceable).

Shell Oil Company will comply with Section 106 of the National Historic Preservation Act of 1966 (16 USC, Sec. 470 F, as amended, 90 Stat. 1320) and the Advisory Council's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR 800) prior to approval of any undertaking which will affect cultural properties included in or eligible for inclusion in the National Register of Historic Places within the mining area.

EPA regulations require a review to determine the best available control technology where potential fugitive dust emissions are equal to or greater than 250 tons per year. The mine operator, in this case Shell Oil Company, must employ the best management practices for fugitive dust, regardless of predicted concentrations during operation. Thus the mining plan and the Agency's approval would use an appropriate combination of the following fugitive dust controls:

- Pavement or equivalent stabilization of all haul roads used or in place for more than 1 year.
- Treatment with semipermanent dust suppressants of all haul roads used or in place for less than 1 year or more than 2 months.
- Watering of all other roads in advance of and during use whenever sufficient unstabilized material is present to cause excessive fugitive dust.
- Reduction of fugitive dust at all coal dump (truck to crusher) locations through the use of negative pressure bag house or equivalent methods. Inclusion of conveyor and transfer point covering and spraying, and the use of coal loadout silos.

Mitigating measures proposed by the company are presented in chapter I of this statement. Legal requirements are decribed in chapter III of the regional statement and administrative alternatives available to State and Federal agencies are presented in chapter VIII of the regional statement. Technical alternatives are in chapter VIII of both this volume and the regional statement.

CHAPTER V

ADVERSE IMPACTS THAT CANNOT BE AVOIDED IF THE PROPOSALS ARE IMPLEMENTED

The reclamation surface, 1,196 acres, would be subject to increased erosion rates (about 2.5 times above normal at the time of reclamation and decreasing thereafter) for long periods of time following reclamation. This would not significantly affect postmining land use.

The localized destruction of several bedrock aquifers, including three coal aquifers, could not be avoided and the quality of the water in the resaturated spoils would decrease. This would not be very significant because water supplied from these sources could be replaced from nearby wells or by tapping deeper aquifers. If the alluvial aquifer cannot be successfully restored, there could be a significant decrease in the flow of Little Youngs Creek. As a result, much of the riparian vegetation would be adversely affected. Some of the deciduous shrubs may fail to become reestablished. Springs along Little Youngs Creek, used for a domestic supply, could become dry.

Air quality would be degraded during mining due to twofold to eightfold increases in concentrations of fugitive dust. Proposed dust mitigation measures do not represent the best available control technology. Both State and Federal primary and secondary standards would be sporadically violated unless the Ash Creek mine emissions were also controlled. Application of best available control technology would be about 75-percent effective in controlling fugitive dust, reducing dust emissions to 1,458 tons/year. Gaseous emissions would increase 615.2 tons/year but would probably not violate standards. Unavoidable secondary impacts would include: reduced visibility and esthetic value for several square miles around the mine, disruption of the stability of the ecosystem in the surrounding area, diminished livestock productivity, and exposure of mine personnel to a higher risk of respiratory disorders.

There would be reduced productivity and permeability of topsoiled materials, which in turn would affect moisture infiltration, vegetation, and wildlife carrying capacity. Development of the soil profiles on the 616-acre pit area would require a long period of time, on the order of decades to centuries, thus, inhibiting reclamation. There would also be unavoidable destruction of the existing vegetation mosaic and loss of species diversity, probably lasting for decades.

Several plant species necessary to some wildlife would be difficult to reestablish as self-sustaining populations. Although sagebrush may be reestablished, it would not be planted in densities required for reestablishment of some premining wildlife populations. There would be unavoidable habitat losses that would lower the wildlife carrying capacity of the area; this may last for decades or longer. Available livestock forage would be impacted for a shorter period of time. Lands would be removed from grazing during the period of active mining, thus losing approximately 2,100 AUM's for the 27 years of development.

The population growth, 462 people by 1990, associated with this mine is expected to be concentrated in Sheridan County, Wyoming, raising the total population to about 22,400. The town of Sheridan would receive somewhat more than half of this influx, causing fiscal difficulties in Sheridan and increasing demands for community services, housing, and recreational facilities in both Sheridan and Ranchester. The socioeconomic impacts from the Pearl mine would constitute approximately 5 to 10 percent of the potential cumulative impacts from the existing and proposed mines in Big Horn County, Montana, and Sheridan County, Wyoming. If a new town were built in the Decker, Montana, area impacts to Sheridan County would be quite different. (See the regional volume of this statement.)

There would be an increase in highway usage, mostly on Highway 338 and the county road leading to the mine. This increase could range from about 40 to about 260 cars per day during the construction period (assuming anywhere from 6 to 1 persons per vehicle). This would be reduced from 22 to 136 cars per day during the active period of mining. This would increase congestion, maintenance costs, and traffic accidents. At full production the mine would add about 400 unit trains per year to the Burlington Northern mainline, raising the total traffic from this area[1] to 6,952 trains/year. There would be a higher incidence of noise, dust, and gaseous air pollution along the right-of-way. Impacts along the mainline due to the Pearl traffic alone (about 6 percent of the total coal traffic from this area) would not be significant; however, in the context of being an incremental addition to the heavy coal traffic coming from the Powder River region, it would be significant.

A more detailed analysis of cumulative unavoidable impacts can be found in the regional statement (chapter V).

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[1]This includes the Decker mines and the Spring Creek mine in Montana, and the Ash Creek and Big Horn mines in Wyoming. This does not include other regional traffic. See the regional statement.

CHAPTER VI

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The Pearl mine would contribute about 6 percent of the total projected coal production from Big Horn and Sheridan County mines by 1981, increasing from the current 32.9 mty to 34.6 mty.

During the 27-year life of the mine (short term), approximately 46.5 million tons of coal would be transported from the Pearl mine. Long-term (postmining) environmental costs of mining at Pearl under the proposed mining and reclamation plan would be primarily the additional physical disruption of the ecosystem on and adjacent to the mining operation--destruction of the soils, vegetation, and wildlife--and the consequent reduction of land-use capabilities.

The long-term biological productivity of the permit area would be lower than before mining. The increased erodibility of the reclaimed land surface (1,217 acres) might result in a loss of some topsoil and a decrease in potential productivity. Water infiltration on the reclaimed land surface would decrease, causing increased runoff and sedimentation for an unknown period of time. Mining could permanently lower or destroy the aquifer in the alluvium along Little Youngs Creek, and, in turn, eliminate some riparian vegetation and wildlife habitat for a long period of time.

Long-term productivity of the disturbed areas would depend to a large extent on the level of management applied both before and after bond release. There would be a long-term loss of the vegetative mosaic and species diversity in the reclaimed area for an unknown period of time. Some shrub species may not be successfully reestablished. Other vegetative species would take years or decades to reestablish at premining levels, therefore reducing the quantity and quality of postmining wildlife habitat for big game, game birds, and birds of prey.

The most significant impacts to air quality on the minesite would be short term. In conjunction with the Ash Creek mine, whose effects cannot be segregated out, Federal and State standards for fugitive dust would be sporadically violated. A long-term source of fugitive dust from the minesite could be the increased wind erosion of reclaimed surfaces until stabilization occurs. The surrounding area, serving as a long-term depository for atmospheric effluent, could consequently be less productive. Town expansions due to mining would be long-term sources of fugitive dust.

Short-term gains would be experienced from the extraction of coal. These include: electrical generation; increases in employment, income, and revenue in the regional area; and profits for the coal company. The long-term economic effect on agricultural activities at the minesite is unknown. On a regional basis it would not be significant; on a local basis, however, there could be a long-term loss of agricultural activity important to the local ranchers and communities.

There would be a long-term investment in land uses resulting from the Pearl mine. Land committed to residential, commercial, and service facility development would not necessarily revert to present uses after the mine closes. The value of the natural landscape for esthetic, historical, and archeologic purposes would be lost for the long term. Any improvements in the highway system as a result of the mine expansion would have long-term benefits for the local population. The mine would cause an additional increment of use and, thus, financial support for the regional public transportation systems, especially air and bus service.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

During the proposed 27-year life of the Pearl mine, 2,403,200 gallons of diesel fuel and 50,000 gallons of gasoline would be consumed annually. Use of electrical power for mining would be an estimated maximum of 11 million kWh per year, for the life of the mine.

An estimated 20 acre-feet of water per year would be used for mining purposes (most would come from mine effluent). Domestic and sanitary water use at the minesite would be about 4 acre-feet per year (probably from a well). Water consumed by the increased population due to the mine would be about 500 acre-feet per year. Thus, about 524 acre-feet of water per year would be lost to other uses.

Federal standards and Montana State guidelines for TSP would be exceeded frequently at the minesite, and sporadically downwind.

Approximately 2,100 AUM's would be lost during the 27 years of active mining.

Approximately 46.5 million tons of coal would be extracted from three coal seams. Assuming an average of 8,756 Btu's per pound, approximately 78,036 million kWh of electricity would be generated from this volume of coal. Approximately 13.5 million tons of coal within the Federal lease could not be recovered.

If the hydrologic integrity of the alluvium cannot be restored, this aquifer would be destroyed for about a half mile along Little Youngs Creek and the coal and sandstone aquifers in the mined area would be destroyed. The total dissolved-solids concentration in water from the spoils would increase, and may average about 5,000 mg/L. This concentration would preclude use of water from the spoils for domestic and livestock needs.

The productive capacity of the reclaimed soils would be lower because of disruption of the soils' physical, chemical, and biological characteristics. The existing vegetation mosaic and species diversity could not be replaced. If water levels in the alluvium are not restored, several species of deciduous shrubs could be precluded from reestablishment. In response to these factors, the carrying capacity for wildlife would be reduced for many decades.

The continuing transformation from a traditional way of life appears, for some people, to be irreversible. Time and money invested in mining and offsite developments would be irretrievably committed. Energy, materials, and labor used in the mining operation would be lost to other uses.

Any cultural resources undiscovered before mining would be irretrievably lost due to mining.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

The Secretary of the Interior and the Montana Commissioner of State Lands may approve the proposed Pearl mine as planned. Chapter III describes the environmental impacts which would occur if the plan were approved without modifications. Chapter VIII describes and evaluates various alternatives to the proposed plan.

A. ADMINISTRATIVE ALTERNATIVES

Administrative alternatives available to the Secretary of the Interior and the Montana Commissioner of State Lands are described in Chapter VIII of the regional statement. These options include rejection, deferral, or acceptance after modification.

B. ALTERNATIVES PROPOSED BY SHELL OIL COMPANY

Shell Oil Company responded to the September 15, 1978 letter sent to them by the Montana Department of State Lands (appendix A) on April 11, 1979. In their response, the company proposed to increase coal recovery by mining through Little Youngs Creek. The company is now completing additional hydrologic studies required prior to mining through the creek so that it can be determined whether or not the area meets the criteria for alluvial valley floors under SMCRA. In addition, the company has requested that a determination of prime farmlands be made by the Soil Conservation Service. If either the alluvial valley floor or prime farmland criteria were met, substantial changes would have to be made in the mine plan. As of May 1979, the company foresees only minor administrative changes in their application in order to assure compliance with State and Federal laws and regulations. The mine plan would be approved only after compliance with regulations is assured.

C. TECHNICAL ALTERNATIVES

Technical alternatives may be required as stipulations to a permit. Modifications, such as different mining procedures, changes in method of transport, or development of selected areas now under lease, have been considered. Such options probably would not significantly alter the impact of mining the Pearl lease, and indeed, many of these options are not viable. The proposed slurry line to Texas from Parkman Reservoir, if ever built, would probably not be built in time for use by Shell Oil Company to transport Pearl coal. If technical alternatives suggested in the review process would affect the overall impact, they will receive consideration in preparation of the final environmental statement.

The alternatives discussed below may be required by the permitting agencies as stipulations to the permit. These alternatives may reduce the impacts of the proposed plan.

1. Geology

During mining impacts can be reduced by monitoring channel geometry of Youngs Creek below the point where mine waters are added to the streamflow. If channel incision begins, the rate at which streamflow is augmented should be reduced until incision stops. Or, the problem could be avoided completely by ground-water disposal of excess waters. This would also reduce changes in surface-water quality.

The susceptibility of the reclaimed surface to increased erosion and deposition can be reduced by: placing topsoil on a roughened spoils surface to inhibit flow along that boundary and to increase downward percolation; reducing the slopes of all reclaimed ephemeral channels so that they are no greater, and, if possible, less than premining channel slopes; reducing hillslope gradients so that they are as much below the required maximum of 5:1 as possible. Long straight slopes containing no breaks should be avoided. Reconstructing slopes with concave, straight, and convex segments, like natural slopes, would minimize the length of the steep slope segments. As current reclamation costs are probably less than $0.75 per residential customer per year, changes in the reclamation plan should not significantly affect cost.[1]

2. Hydrology

When Little Youngs Creek is reconstructed, the bottom of the channel could be made to coincide with the top of the replaced alluvium. The channel could be armoured so as to prevent excessive erosion. The restoration of the alluvial aquifer could be enhanced by placing clay from the spoils on the restored surface under the alluvial aquifer, and compacting this clay to a maximum possible density with sheep-foot rollers. Another option is to not permit the mining of Little Youngs Creek. This would be necessary if the Little Youngs Creek valley meets the criteria of alluvial valley floor, as defined in SMCRA.

3. Air Quality

a. Mine operation

The most significant reduction in particulate emissions could be achieved by suppressing these emissions from the coal-handling facilities. Supression techniques include: (1) equipping all coal-storage and crushing facilities with particulate fabric filters; (2) completely enclosing all coal-conveying systems; (3) installing water sprayers at all transfer points; and (4) installing a negative pressure haul-truck dump.

Fugitive emissions from haul roads could be reduced from 808 tons per year to 404 tons per year by increasing the rate of water spraying from 14,000 gal/day to 75,000 gal/day, and by utilizing the water truck for spraying 5 days a week.

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[1]Open-file report, State task force, 1979.

Hot oil sprays applied to coal loaded onto unit trains would suppress coal dust, keep coal from freezing in the winter, and enhance the combustion properties of the coal; but they may also increase the sulfur content per BTU of coal. The cost (Open-file report, State task force, 1979) passed along to the consumer would be a maximum of one-tenth of one percent of the residential customer's yearly power bill. Fugitive dust along the railroad corridor and at the loadout facility could be reduced from 4-8,000 tons per year to 0.5-1,000 tons per year (assuming 87.5-percent efficiency).

b. Air monitoring

A comprehensive air monitoring system could be installed to ensure that the impacts to "ambient air" during and after mining are characterized.

When the Montana Department of Health and Environmental Science's Air Quality Bureau takes over permit review responsibility for PSD permits from the EPA, it could require the following:

- A thorough baseline air-monitoring network that provides baseline air quality truly characterisitic of the area. High-volume air samplers could be placed near each existing different activity, e.g., a ranch operation, undisturbed habitats, drainages, and hilltops.

- Air monitors set up within and outside the permit area, to remain in place for the life of the mine.

- Particle size distribution and trace element analyses as part of the baseline characterization.

- At least 2 years of complete meteorological data gathered so that fugitive dust movements from the minesites can be modelled. This will determine whether or not the proposed operation would exceed the allowable increase in air pollution.

- Adequate measures to reduce fugitive dust, and best available coal handling facilities and storage.

- Adequate measures to reduce noise from machinery.

4. Soils

Topsoil stockpiles could be made more extensive to allow for a reduction in total height and to maintain the viability of a greater volume of soil. More extensive mulching would reduce the susceptibility of the surface to wind erosion.

5. Vegetation

Impacts to vegetation could be reduced by the following alternative measures:

- Limiting reclamation use of topsoil and nontoxic substrate to material not exceeding 2 ppm molybdenum content--the soil suspect level for the element.

- Drilling all seed on slopes of 3:1 or less, in lieu of partial broadcasting. The chance for successful germination and establishment, whereby seed is covered with soil, is greatly increased by this method (Anonymous, 1977; Wambolt, 1976; Cook, 1966).

- Inoculating all legume seed with the proper bacteria within 48 hours (Anonymous, 1977) prior to planting. Legumes are dependent upon certain bacteria for making nitrogen from the air available for use by the plant. Inoculation of legumes by the proper strain of Rhizobia bacteria can insure natural nitrogen availability in the soil as legumes decompose in the soil (Vallentine, 1971). This available nitrogen would be necessary after that from initial artificial fertilization has been depleted.

- Inoculating the soil surface with nitrogen-fixing blue-green algae, by spraying in water solution, would increase surface stability, organic matter content, water-holding capacity, total nitrogen, and available phosphorous, and would decrease the available sodium and the soil pH (Singh, 1961).

- Hand collecting seed of native species, not available commercially, for use in reclamation.

Alternative postseeding management measures for reducing impacts include imposing stipulations for:

- the control of grasshoppers--the only insects which appear to present a problem on reclamation, to date. This is partially because the exposed soil surface presents favorable egg-laying conditions.

- the protection of shrub and browse species from grazing by wildlife, until the plants are well established, could promote reclamation.

6. Wildlife

Tree and shrub species valuable to wildlife could be planted on revegetated areas in densities similar to those existing before mining.

Human activity in areas not being mined could be kept to a minimum to reduce wildlife disturbance.

7. Land use planning

Land use planning could mitigate growth impacts if it is properly undertaken. After mining, the return of the county road to its original route would allow the return of soils, with agricultural potential (IIIe) to production and would make flood irrigation feasible. Additionally,

the numerous small fields created by relocating the county road could again be less expensive and time consuming to manage if the road were returned to its original route. Another alternative would be to reroute the county road to avoid dissecting these fields as much as possible.

8. Transportation

Paving of the county road between Wyoming 338 and the minesite would greatly improve traffic conditions over this 5-mile route. Grading and surfacing of county roads to provide an alternate route between the Pearl site and U.S. 87 (temporary I-90) near Ranchester would provide a less circuitous route to points west and north, and would relieve some of the traffic burden on Route 338. Development of a mass transportation system to the mine would decrease energy consumption by employees.

9. Esthetics

An alternative for reducing visual impacts would include the painting of buildings, equipment, etc., with neutral colors which blend with the surroundings. Visual impacts would also be reduced if fugitive dust were more stringently controlled, and if seeding mixtures used in reclamation contained more plant species similar to vegetation in the unmined areas.

More alternatives are discussed in chapter VIII of the regional statement.

CHAPTER IX

CONSULTATION AND COORDINATION

A. ORGANIZATION OF STATE AND FEDERAL INTERAGENCY TASK FORCE FOR THE ENVIRONMENTAL STATEMENT

Instructions to prepare regional and site-specific environmental statements for the northern Powder River coal basin were issued to the Geological Survey and the Bureau of Land Management by the Secretary of the Interior on April 29, 1976. The Geological Survey was designated as lead agency for this statement. Because of some duplicate or closely related actions pending before State and Federal agencies, and because of the similar requirements of the National and the Montana environmental policy acts, the State of Montana joined with the Federal task force in August 1976 in the preparation of these environmental statements.

B. DEVELOPMENT OF THIS STATEMENT

Public notice was given in June 1977, that an environmental impact statement was to be prepared on the proposed Pearl mining and reclamation plan by a joint State-Federal task force. The State task force personnel were under the administrative supervision of a State coordinator attached to the office of the Commissioner of State Lands.

In preparation of this draft statement, data and/or review comments were solicited from a wide range of State and Federal agencies, county and city officials, consultants, and private interest groups.

A close working relationship was established with State and local agencies in Montana. All divisions of Montana State government having jurisdictional interests in the projects have been contacted and many have supplied data.

During preparation of this draft environmental impact statement, consultation and coordination was made with the following organizations:

Government:

Department of the Interior:

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Reclamation
- Fish and Wildlife Service
- Heritage Conservation and Recreation Service
- National Park Service
- Office of Surface Mining

Government--Continued:

Other Federal agencies:
- Advisory Council on Historic Preservation
- Department of Agriculture
  - Forest Service
  - Soil Conservation Service
- Department of Commerce
  - Old West Regional Commission
- Department of Energy
  - Bonneville Power Administration
- Department of Health, Education, and Welfare
- Department of Housing and Urban Development
- Department of Labor
  - Mine Safety and Health Administration
- Department of Transportation
- Environmental Protection Agency
- Federal Energy Regulatory Commission
- Interstate Commerce Commission

State of Montana:
- Office of the Governor
- Agricultural and Experiment Station
- Bureau of Mines and Geology
- Department of Community Affairs
- Department of Fish and Game
- Department of Health and Environmental Sciences
- Department of Natural Resources and Conservation
- Department of Revenue
- Energy Advisory Council
- Environmental Quality Council
- State Historic Preservation Office

Local:
- Big Horn County Planning Director
- Board of Commissioners, Big Horn County, Montana

State of Wyoming:
- Office of the Governor
- Board of County Commissioners, Sheridan County, Wyoming
- Mayor, City of Sheridan
- Sheridan County Planning Commission

Non-Government:

- Burlington Northern Railroad
- Meadowlark Group
- Milwaukee Railroad
- Montana State University
- Mountain Bell Telephone Company
- Northern Cheyenne Research Project

Non-Government--Continued:

Northern Plains Resource Council
Shell Oil Company
University of Montana
Westech, Inc.
Yellowstone-Tongue Areawide Planning Organization

The Shell Oil Company provided data and information on their proposed activities and greatly facilitated field observations and data collection by task force members.

Archeological reconnaisance of the Pearl area was provided by the contractual services of the Division of Archeology and Cultural Resources, Mineral Research Center, Montana College of Mineral Science and Technology Alumni Foundation, Butte, Montana, to supplement the data provided by the Montana Departments of Natural Resources and Conservation; Highways; Health and Environmental Sciences; and Fish and Game; Montana State University, Department of Agricultural Economics; and the University of Montana Department of Environmental Studies.

C. REVIEW OF STATEMENT

In accordance with guidelines of the Council on Environmental Quality and the Montana Department of State Lands, copies of the draft statement will be made available to the public for their comments and suggestions. Comments are also solicited from the above-mentioned agencies and organizations.

The draft environmental statement is available for public review at the following places:

U.S. Geological Survey Public Inquiries Office, Room 1012, Federal Building, 1961 Stout Street, Denver, CO 80202

U.S. Geological Survey Library, 1526 Cole Blvd., Golden, CO 80401

U.S. Geological Survey Library, Room 4A100, USGS National Center, 12201 Sunrise Valley Drive, Reston, VA 22092

Montana Department of State Lands, 1625 11th Ave., Helena, MT 59601

Bureau of Land Management (West of Miles City), P. O. Box 940, Miles City, MT 59301

Parmley Billings Public Library, 510 North Broadway, Billings, MT 59103

Sheridan County Fulmer Public Library, 320 North Brooks, Sheridan, WY 82801

Big Horn County Public Library, 419 North Custer Ave., Hardin, MT 59034

The Rosebud County Library, 201 North 9th Ave., Forsyth, MT 59327

A limited number of copies are available on request from the United States Geological Survey, Land Information and Analysis Office, Box 25046, Mail Stop 701, Federal Center, Lakewood, CO 80225; and the Montana Department of State Lands, 1625 11th Ave., Helena, MT 59601.

Written comments on the draft statement will be accepted for a period of 45 days subsequent to the filing with EPA and the Montana Environmental Quality Council. All substantive comments received will be considered in preparing the final environmental statement on this proposal. Written comments should be addressed to Director, United States Geological Survey, 108 National Center, Reston, VA 22092.

Comments on the draft environmental statement are sought from industry, officials from all levels of government, environmental groups, and concerned citizens.

CHAPTER X

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STATE OF MONTANA

DEPARTMENT OF STATE LANDS

MAILING ADDRESS: CAPITOL STATION
OFFICE: 1625 11TH AVENUE
HELENA 59601
(406) 449-2074

Certified Mail No. 22137
RETURN RECEIPT REQUESTED

September 15, 1978

N. J. Isto
Shell Oil Company
Two Shell Plaza
P.O. Box 2099
Houston, TX 77001

Re: Application for permit #00065 for Shell Pearl Project

Dear Mr. Isto:

The Department of State Lands has reviewed your application for permit #00065 received 1/20/78, and as revised by Connie Cole's letter of 5/31/78. The submitted material has been reviewed for compliance with the Montana Strip and Underground Mine Reclamation Act, the Rules and Regulations adopted on July 25, 1978, pursuant to Title 50, Chapter 10 R.C.M. 1947, the Coal Conservation Act and the Rules and Regulations adopted pursuant to the Coal Conservation Act.

The application is deemed not complete at this time. The Department has listed specific deficiencies in your application. Each deficiency should be addressed with a positive commitment in the narrative of your application. As expalined in my letter of 12/16/77, all revisisions must be in the form of complete replacement pages and/or plates. To avoid confusion, please label each replacement page with "Revised" and the date.

Since the new regulations were not availabe at the time your application was submitted, please review the new regulations which are enclosed. Each section and subsection should be addressed. If a section does not apply it should be so stated. If a negative determination is involved, justification for that determination should be included.

The following are the deficiencies in your application. Be as specific as possible in your response.

Page A.3.-1 Application (Location and Area)

Title 50, Chapter 10, R.C.M. 1947

1. Section 6, (5)(a). Once Shell has eliminated all unused portions of land from their permit area, the legal description of the "area of land to be affected" on the permit application form and in the permit application narrative should include all bonded areas. The present legal description covers only the federal lease areas.

2. In the metes and bounds description of the south lease area on p. A.3.-1, the value of 662.75 ft. (last sentence on page) appears to be incorrect.

   Metes and bounds descriptions of areas obtained by scaling from a map are not acceptable.

   Rules adopted pursuant to Title 50, Chapter 10, R.C.M. 1947

3. S10270, (4)(b). A listing of significant or unique scenic and/or geologic sites should be submitted.

4. S10270, (4)(c). An explanation showing the area to not possess such characteristics as defined in Section 9(2), Title 50, Chapter 10 should be submitted.

5. Page A.3.-7 Surface Owners Affected Within 0.5 Mile

   Section 6 (5)(b). In the permit application, section A.3.c., the surface ownership appears not to be correctly described as follows:

Section	Comments
1	PSO land not correctly described (no section number, BLM not included
28	BLM not included
29	This section not mentioned
32	PSO not listed
33	PSO not listed

   For the purposes of a permit application, "affected area" is defined as any area to be bonded at any level under a mining permit, plus any buffer zones.

6. Page A.3.11 Mineral Owners for Area to be Affected

Section 6 (5)(c). In the permit application section A.3.d., all mineral owners of lands to be bonded at any level under a mining permit must be included. The mineral ownership appears not to be correctly described as follows:

Section	Comments
1	PSO land not correctly described (no section number)
29	This section not mentioned
32	Shell should be described as owner of entire section
33	Shell should be described as owner of entire section
34	This section not mentioned

7. Page A.3.-12-A.3.g Other Permits - states that "they currently hold Prospecting Permit Number 75120." This should read "they have held."

8. Page A.3.-14 Climatological Data

In the climatological data section, several numbers are mixed up on the figures. Page A.3.-16 "Figure A-5" should be "A4." Page A.3.-26 "Figure A-6" should be "A-5", and "Figure A-7" should be "A-6".

9. Page A.3-46 - A.3.-189 Arcaheological Survey of the Pearl Area

Information pertaining to the nomination of 5 of the 15 archaeological sites, within and surrounding the proposed areas of disturbance, to the National Register of Historic Places must be submitted. Shell must indicate the status of the mitigation procedures and submit results of additional work that may have been done.

Prime Farmland

10. Shell has not yet addressed the question of whether prime farmland exists on its proposed permit area. In order to make such a determination, Shell should provide information on the cropping history of areas cultivated for 5 years out of the last 20 years, whether these areas are being irrigated or could be from a developed water source, the intensity of management. This should include areas delineated on the vegetation map as hay meadows, "old oats field", created wheatgrass and smooth brome areas.

Soils

11. It does not appear that sufficient area has been set aside for topsoil storage. In any case more storage area will be needed to comply with the topsoil segregation regulations discussed under Topsoiling. Also, what is the difference between a "temporary topsoil area" and a "topsoil storage area"? Shell has one of which on Plate 10.

12. Shell has made recommendations for topsoil salvage in each soil series described. From an operational standpoint, how does Shell propose to salvage topsoiling material in complexes where 2 or more soil series exist with different recommended salvage depths?

13. The Department feels that the surface 4"-6" of Travesilla loam is suitable for salvage. Some coarse fragments do not constitute a problem in salvaged materials. In addition, the underlying subsoil down to sandstone may be useful in establishing a suitable substrate for re-establishing Ponderosa pine and skunkbush sumac (see revegetation section).

14. The Department is not at this time willing to write off the Midway series as salvageable material. Further study of this series will be done to determine if the surface material would have any usefulness, perhaps in association with other soils.

15. The salvage depth of Thedalund and Cushman should be designated as down to bedrock instead of a specific depth of 24" since these soils appear suitable to bedrock, the depth to which may vary.

16. Wibaux soils may be useful in re-establishment of Ponderosa pine and skunkbush sumac (see revegetation section).

17. On page B.1.-10 of the soils portion of the application, the salvage of Spearman loam in the unit 362D was intended to be 24" not 4". In any case, salvage of this series should be to bedrock, the depth to which may vary.

18. It appears that salvage recommends - twins (or lack thereof) by Shell for several soils are premature due to variability of salt content and/or clay in subsoils of these series. The soils of concern include the Heldt, Lohmiller, McRae, Winnett, and Korchea series. These soils should be intensively sampled and analyzed for Ec and texture to determine their suitability either now or as a routine aspect of salvage operations if a permit is granted.

19. In the analytical results, there were many examples where the textures as determined by mechanical analysis did not agree very well with the field textural determinations. In addition, there were several examples of quantitative textural results in a given

profile that changed dramatically when comparing contiguous horizons. Examples of these problems include Chugter (sample #60) Haverson (#51 & 65), Heldt (#'s 48 & 64), Lohmiller (#'s 62 & 63), McRae (#54), Midway (#40), Renohilt (#'s 50 & 66), Thedalund (#69), Thurlow (#70), Winnett (#'s 45 & 63).

The Department would like Shell to investigate these problems in an effort to resolve them.

20. Material from the Alice series and other more abundant loomy soils should be deliberately mixed with soils with high clay content (e.g. Thurlow, Renshill and Lohmiller) to moderate the sandy textures of the Alice and the Clayey textures of the latter named soils.

21. The map labeled "Soils Affected by Development" shows the area in the far northwest corner of the permit area as being disturbed and all calculations of available and suitable topsoiling material were apparently made on this basis. Since no disturbance is indicated in this area anywhere else in the application, the calculations of available topsoil will require revision. Also, any other changes indicated elsewhere in this letter for the areas to be disturbed must be taken into account for this calculations. In addition, calculation of the average depth of topsoiling material available over the whole disturbance area should be made.

22. Why were the horizon designations for various profiles of the McKae, Thurlow, Winnett, and Wibaux series apparently not complete?

23. The following errors were found in the narrative and maps:

    a. In the soils analysis results, "Chugster" should read "Chugter".

    b. On the soils map, "Kochea" should read "Korchea".

    c. On page B.1.-9 in the paragraph relating to the Midway - Thedalund complex, "8-15 percent slopes" should read "15-25 percent slopes".

    d. On the map, sample site 49 is located on an undesignated delineation.

24. The soils overlay does not match up very well with the aerial photo when using the match points.

25. In the descriptions of some mapping units, it was indicated that "small areas" of certain series occurred in these mapping units. Of what size were these "small areas"?

26. If there are any soils which were not mapped because of the 2 or 5 acre limitation in the guidelines but could easily be shown on the map at 1" = 500' and for which information is available or which can easily be seen on the aerial photo, the Department feels it would be beneficial to have these soils shown on the map.

Topsoiling

27. The current regulations regarding topsoiling should be addressed point by point, since some of these were not in existence prior to submittal of your application.

Specific comments on topsoiling follow:

28. Page F.2 - The Department does not agree with the desireability of creating depressions on the top of topsoil stockpiles due to the potential for large scale erosion if dikes breached and due to the increased potential of slumping when soil materials become saturated.

29. Page F.-2 - Shell should reevaluate the usefulness of contour furrows since mulching and quick cover crops will be employed. The Department does not advocate significant surface manipulation unless it is essential.

30. Page F.-3, Section F.2.c. - In the second paragraph, the use of the word "impeded" appears incorrect.

31. Page F.-4 - In the first paragraph, "cultivating repeatedly" would repeatedly expose the soil to erosive forces which is undesireable.

32. Page F.-5 The depth of topsoil to be replaced will depend on the total available which is not completely known at the present, pending the responses to several questions in the soils section.

33. Page F.-5 - The reference to the use of "heavy" textured replaced topsoil in the sevale bottoms and coarse - textured soils on the convex slopes should be elaborated on. What soil series or specific soil textures are being referred to in each case? Also, consideration must be given in the regard to DSL comments in the hydrology section on reestablishing drainage bottoms.

Overburden - South Lease area only

34. The Department feels there is considerable material that is not conducive to revegetation if placed in the rooting zone:

a. The following materials are sodic and high in clay content: innerburden between the G & M seams in holes 5 and 8, the overburden from 50 feet to the G seam in hole 6 and the innerburden between the D & G seams in hole 7.

b. Some lower overburden and innerburden strata elevated zinc and nickel levels.

c. The D ad G seam innerburden represented by hole 5 is high in clay (unweighted average = 42%).

35. These materials must not end up intact within 8 feet of the surface. Shell's mining and reclamation plan does not completely address how these materials will be buried below 8 feet. In general, it presently appears that the surface 20-30 feet of materials is the best for reestablishing a suitable rooting zone medium.

36. The plan for initial stockpiling of overburden during the first 2 years of mining should address the segregation of suitable from undesireable materials so that in the final use of these materials for backfilling, the undersireable material can readily be buried.

37. The Department would like a detailed description of the methods used for analysis of molybdenum since most strata exhibited elevated values from the standpoint of DSL's experience.

38. No data was presented on that portion of the south lease area west of the faults. This is important since the coal seams and stratigraphy are quite different on either side of the faults. The Department would like some data on the chemical and physical nature of this material.

39. Shell will need to obtain a waiver of the federal requirement in the 211 regulations of 1 overburden analysis hole per 40 acres of mining disturbance area.

<u>Page B.2.-378 Geology</u>

40. Section 6 (6)(i). A map should be submitted which shows the location of <u>all</u> test boring holes used in compiling data for this application pursuant to S10370(b) of the rules governing the Strip Mined Coal Conservation Act. The Cross Section Map, Vol III, is not sufficient. Specifically, Shell should submit all drill logs for holes used in compiling the cross-sections of Vol. III in the application.

41. Also, in Table B.2.-1 of the permit application, holes WR-27, WR-34, CP-41, and 2222 are not shown on the cross-section map. Hole CP-34, shown on the cross-section map, is not listed in Table B.2.-1, nor is there any drill log for it. Hole 22-22 makes its only appearance in Table B.2.-1.

42. Cross-sections TT' and S-S' do not agree with Plates 1 and 1A.

43. An accurate map (1:500) showing the surface geology and structure of the area should be included.

44. Will the O and R seams be mined where displacements due to faulting make them reachable by surface methods (such as in south pit cross-sections (A-A', B-B', C-C' and D-D')? A commitment is needed.

Preplanning - Vegetation

45. Transects DC 1 through 10 and PV 37 and 38 were not located on the vegetation map.

46. A page should be inserted identifying the range sites of the transects, and the condition of transects should be expressed in percent of climax.

47. Production figures for the hay meadows along Young's Creek and Little Young's Creek should be submitted.

48. S10313 The section on prime farmland must be addressed. If it is determined that no prime farmland exists on the area, the reason for the negative determination should be stated.

Wildlife

49. The wildlife survey does not address the impacts of the mine on wildlife utilizing the area. While the study was started prior to the release of the guidelines requiring a discussion of impacts, the requested data is necessary to adequately assess impacts to wildlife, and does not involve significant field time. The biologist who conducted the study should submit a discussion of mining impacts on wildlife, possible mitigations of these impacts, and suggested reclamation techniques to ensure that reclamation will meet the requirements of 50-1045(a) of the Montana Act.

50. More information is needed concerning grouse nesting, brooding, and brooding rearing areas utilized by the sharptail from the dancing ground located on the rail loop. The radio telemetry study to be conducted next year should provide the necessary information. The possibility of moving the loop slightly to go around the dancing ground rather than through it should be addressed.

51. In the areas to be mined, there are areas with shallow soils containing shrub and tree species confined to these areas (particularly Ponderosa pine and skunkbush sumac). To date the Montana Reclamation Division has not seen successful reclamation of Ponderosa pine or skunkbush sumac. Shell should submit a detailed plan to reclaim these areas to the premining productivity as required under 50-1042 and 50-1045 (a). (Also see comment 125 of the revegetation section).

52. Rock outcrops are important to many wildlife species. Detailed plans should be submitted for mitigation of the impact of the destruction of these areas and possible reclamation techniques.

53. Skunkbush sumac is important to wildlife. A detailed study with perhaps special techniques should be utilizied to ascertain the amount of wildlife utilizing sumac and to differentiate the use between cattle and wildlife.

Hydrology

Groundwater

54. Page B.5.-2 Hydrologic Map

The impact on the groundwater flow systems due to mining through the semi-impermeable boundaries (faults) is in question. Submit data to answer this question.

Is there evidence of local recharge along faults (fluctuations of water levels in wells along faults during precipitation and snowmelt)?

Is there evidence of water level fluctuations in wells adjacent to Young's and Little Young's Creeks that correlate to gains and declines in stream discharge?

55. Page B.5.-4 1. Present the hydrologic data from the proposed mining sites which indicate faults are barriers to groundwater movement. The significance of the fault zones to groundwater movement must be understood to enable the determination of potential impacts of mining through the fault zones.

56. Page B.5-5 1. "In the Pearl area, however, these units are either absent, do not contain water or have very restricted lateral continuity and are not aquifers". Present data to support this statement.

57. Page B.5-6 Present data which indicate groundwater recharge occurs across the fault into the northwest pit.

58. Data should be presented to indicate the potential for a reversal of hydraulic gradient from northeast to southwest, and the movement of groundwater from the Young's Creek alluvium into the south pit.

59. Page B.5-7 Submit all data from which hydraulic connection between Little Young's Creek and the G -coal bed was concluded.

60. "In the east part of the proposed pit, the M and G coal beds are close together and are considered 1 aquifer". Is there a water level difference between aquifers (open hole or completed well)? What is the spacing between the aquifers and what is the composition of the spacing material.

61. Are there available data from the PSO mine to determine the impacts on the groundwater upgradient from the proposed south pit.

62. Page B.5-13 "Pit inflow will be drived from a principal sources - movement of groundwater into the pit through interception of aquifer water and movement of groundwater from storage into the pit." This statement needs clarification - explain the differences between the 2 sources.

63. Page B.5-17 Submit data, and explain techniques used to calculate the hydraulic properties of the aquifers. Include pumpt test method (slug, constant discharge, etc.) length, discharge, observation well distances.

64. Page B.5-27 "Faulting and aquifer outcrops significantly limit effects of aquifer dewatering due to mining". This statement must be substantiated with data. It is not adeuqately demonstrated in the available data.

65. Page B.5-32 "Well 5 and 26 (Plate 3) are approximately 2 miles down gradient from the northwest pit and are reported to be in coal seams (which seams?). Some lowering of the water capability may occur in these wells, however, they are so distant that drawdown effects should not be significant". What about several years later? If the potentiometric maps (Plate 1 and 1A) are correct an impact can be expected.

66. All data points (drill holes) should be shown on the cross-sections so that the accuracy can be determined.

67. Do the data indicate burn zones (clinker) are continuous across faults? Some cross-sections indicate they are and others indicate they are not. It is not clear whether faults occurred before or after the burns occurred.

68. Data must be collected (wells) to determine whether clinker zones form aquifers, recharge areas, conduits, etc.

69. Determine the relationship of mining to the alluvial aquifers along Little Young's Creek and Young's Creek:

a. Determine whether there is hydraulic connection (and its significance to the proposed south pit) between the proposed mining area, porcelanite, M and G coal seams, alluvium and streamflow.

b. Observation wells should be constructed in the burn areas within the mining area to determine:

   1. If the clinker zones are saturated;

   2. If the clinker acts as a conduit for the movement of groundwater from or to the alluvial aquifers along Little Young's and Young's Creek.

   3. Pump tests should be conducted for a fairly long time period to determine the hydraulic connection. A flume should be located on Young's and Little Young's Creeks during the pump test to determine if there is a decrease in discharge due to pumping.

c. Gain-loss studies should be conducted on Little Young's Creek and Young's Creek to quantify the groundwater-surface water interaction. The amount of groundwater-surface water interaction must be delineated to allow a determination as to whether or not the perennial streamflow of Young's and Little Young's Creeks will be affected during mining and whether the perennial nature of the streams can be reestablished after closure of the mine.

<u>S10330 Water Quality: Impoundment, Drainage, and Treatment</u>

70. S10330(1) General provisions - A commitment must be made.

71. S10330(2) Impoundment and treatment.

72. S10330(3) Dranage - commitments are needed.

73. S10330(4) Monitoring.

74. S10330(5) Diversions.

75. S10330(6) Sediment control measures. All design specifications must be included to show they meet the criteria.

76. S10330(7) Discharge structures. If discharge structures are used design specifications must be included.

77. S10330(8) Acid and toxic materials. A commitment is needed.

78. S10330(9) Groundwater

a. Shell should indicate what steps will be taken to restore approximate premining recharge capacity.

b. Explain backfilling method.

c. A postmining groundwater monitoring plan should be submitted.

79. S10330(10) Water Rights and replacement - A commitment is necessary.

80. S10330(11) A determination has been made that the valleys of Young's and Little Young's Creeks meet the characteristics necessary for preliminary identification of alluvial valley floors as described in the Office of Surface Mining Draft guideline entitled "Technical Identification and Study of Alluvial Valley Floors." The Department requests that Shell follow the proposed guidelines for further study and final determination of the presence of an alluvial valley floor as outlined in the same draft guideline. Although the draft guideline is not final at this time and is not enforcable by law the Department feels this is the best guidance provided at this time for evaluating potential alluvial valley floor areas.

81. S10330(12) Permanent impoundments.

Title 50, Chapter 10, R.C.M. 1947

82. Section 6(6)(c). A map should be submitted which shows the features listed in this section. "All streams, creeks, other bodies of water, roads, etc., within 1000' of the permit boundary.

83. Section 6(6)(f). The requirements of this section should be met. Final surface water drainage plan.

84. In order to evaluate the stability of the reclaimed surface after mining baseline information must be collected for reference purposes. The Department requests that Shell collect sediment information from both Young's and Little Young's Creek above and below the area to be disturbed. Samples should be taken to allow the development of a flow, sediment discharge relationship that will characterize the sediment regimen of the drainage. The sediment samples should be analyzed for textural composition using sieve and hydrometer methods and tallied for total sediment being produced from the basin. It would be appropriate to take samples at locations that coincide with surface water stations and the stream flow should be measured at the time of sampling. Standard U.S.G.S. sampling procedures should be used in conjunction with a DH48 depth intergrated sampler.

85. The Department requests that Shell identify the procedure used to estimate sediment yields on page B.5.68. For purposes of comparison for bond release after minng and reclamation Shell should establish hillslope erosion monitoring sites at representative locations on and around the area to be disturbed. The monitoring technique should parallel those outlined in The Vigil Network: Preservation and Access of Data by W. W. Emmett and R.F. Hadley (Geological Survey Circular 460-C).

86. Page B.5.59 mentions that no water quality information is available for high flows on Little Young's Creek. The Department requests that this information be collected.

87. The Department requests that Shell devise a plan to return materials of similar texture and gradation as the existing stream bottom materials, to be placed in the reclaimed drainage channels. Shell should prepare an evaluation of existing degree of compaction of surface and subsurface materials along reclaimed drainages to similar conditions.

Page C.1.-1 Mining and Reclamation

88. S10310(1)(c)(ii) Slope measurements as prescribed in this section must be submitted.

89. The final reclamation topography map for the South Pit (Plate 3, Vol. III) is unacceptable for the following reasons:

A. The map contour lines are at the odd interval of 16.67 ft. Five feet would be a preferable interval.

B. Slopes no greater than 5:1 will be accepted. Shells' post-mining contour map shows slopes locally as high as 2.6 to 1.

C. The lease boundaries shown in Plate 3, Vol. III do not agree with those in Plate 10, Vol. III, or the metes and bounds description of the lease boundary.

D. Shell should address moving the pit boundaries out from the lease boundary such that the pit walls will intersect the uppermost mineable coal seam on the lease boundary. This provision would not apply along the Wyoming border where all disturbance will end 100' from the property line (buffer zone). All additional areas so included within the pit limits and disturbed at the mining level of disturbance would have to be bonded at that level.

E. Reclaimed contours for roads, the railroad loop, etc., should be provided. Present reclamation contour maps show only the pit areas.

F. Maps showing final reclaimed contours should show sufficient undisturbed contours of surrounding areas to allow evaluation of how well the reclamation blends into the undisturbed areas.

G. The Department would like Shell to design the main drainage in the southern mining area to reflect the profile, cross section and bed and bank materials of the existing drainage. The drainage design should provide a concave longitudinal profile with no convex portions that result from mining. This request will require that a survey be made of the existing drainage as outlined in the Department's guidelines. The results should be presented in a format that can be superimposed for easy comparison.

It also appears that the long east west trending south facing slope of the south pit needs to have drainage provided from the area. The Department requests that Shell design at least two additional drainage basins from this area.

90S10310(1)(e) Small depressions must be addressed; if none are planned it should be so stated.

91. S10310(1)(g) C.1.m. should be rewritten to reflect the language in the newly adopted rules.

92. S10310(1)(h) Only one water truck is shown in Table C-3 of Vol. III; what provisions are being made in the event that this truck breaks down? Will the operation shut down? Does Shell plan on using chemical dust supressants?

93. S10310(1)(j) A statement is needed that if toxic materials are found the requirements of this section will be met.

94. S10310(1)(m) C.1.i. Should be expanded to address all of the subsections of this section.

95. S10310(2)(c) A commitment is needed that all grading will be done along the contour.

96. S10310(2)(d) A commitment to regrade and stabilize rills and gullies pursuant to the language of this section is needed.

97. S10310(3)(a) Mining can proceed to the Montana-Wyoming boundary only if there is no property line along the boundary S10310(3)(a) states "All mining activities, including highwall reduction and related reclamation, shall cease at least 100 feet from a property line. . ."

Presently, mining activities must cease 100 feet from the Shell PSO and Shell - Consolidation Coal property line, which coincides with the Montana -Wyoming boundary.

98. S10302 (4). Buffer zones should be clearly shown on the permit or bonding map. (Also see S10310(3)(a)).

99. S10310(4)(d) Visible markings as provided for in this section must be erected. A description of the markings should be submitted.

100. A fill across Little Youngs Creek for the rail spur is not acceptable. The railroad fill across Little Young's Creek will restrict wildlife movement along the valley floor, pose geomorphic obstacle to a stream that normally migrates within the constraints of the valley floor, create a large disturbance that is not essential and would encroach on a valley that at a preliminary stage meets the criteria for designation as an alluvial valley floor. For these reasons the Department requests that Shell consider alternatives such as a bridge or trestle to replace the proposed railroad fill.

101. S10310(5)(a). Plans should be submitted for all structures that cross streams, drainage channels, ditches, etc. Road alignments should be graded such that runoff from roads and their ditches will not overtop into drainages or streams (road surfaces and ditches over drainages should be higher in elevation than surrounding road surfaces and ditches wherever possible). This may necessitate additional settling ponds.

102. S10310(5)(ii, iii, and iv). Plans should be submitted to cover the design of roads to minimize their hydrologic impact. Road gradients, ditch cross-sections, culverts, etc., should be shown in as much detail as would be required for a construction crew to build it. Plate 14 of Vol. III will not suffice. All water control structures must be designed to handle peak runoff from a 10 year -24 hour storm. All design calculations should be shown. The design technique should be reviewed by the Department prior to the next submittal.

103. S10312(6). Plan and elevation drawings of the spoil pile area at the largest configuration(s) of the spoil pile(s) should be provided since Shell's backfilling plan calls for burying of the innerburden at a lower level than the overburden, and mixing of the two will not be accepted by the Department; the spoil pile plan should include segregated piles. A statement of the number of cubic yards to be stored should be provided.

104. The mining plan should contain an alternative method of handling spoils whereby the northwest portion of the coal lease is used as the overburden storage area in the initial years of mining. Mining after about year 10 would see the south portion of the lease being used for temporary overburden storage. Some reclamation of the mined areas would have to be deferred to around year 20, but so would reclamation of the present overburden storage area, which would not even have to be disturbed under an alternate plan such as this. Such a plan also may be used to advantage to take care of any subsidence which is bound to occur during the life of the mine.

105. Rules Governing the Strip Mined Coal Conservation Act
Shell should submit information as stated in S10370(1)(c).

106. A description of coal to be left unmined should be included.

107. A10312(6). A plan including plan and elevation drawings of the spoil pile at its largest configuration should be submitted. The plan for stabilizing the spoil should be submitted also.

108. Section 6(7). Shell should submit a more detailed breakdown on the estimated cost for backfilling using the guidelines. Shell should address the subject of potential subsidence in their very deep pits and what they intend to do should a program arise. A plan for monitoring subsidence should be submitted.

109. Section 10(3)(f). Shell should address this section of the Act. "Adopt measures to prevent land subsidence." Compaction of spoils to a certain density figure should be considered.

110. Section 10(3)(g and h). A plan for waste handling and disposal should be provided.

111. Section 11(3). Because of the two small areas allotted by Shell to topsoil storage, plans showing these piles in their largest configuration, in plan and elevation views should be provided.

112. S10310(1)(c)(i). Slope measurements as prescribed by this section should be submitted.

113. The location of the proposed road and railroad loop and spur must be staked for inspection as outlined in S10210(4)(d).

114. The haul road for the south pit as currently depicted will impinge on the valley floor of Little Young's Creek and most likely intersect the water table surface in the alluvial aquifer. The Department therefore requests that Shell locate their haulroad a minimum of 100 feet from the stream bottom and to address the hydrologic impact of the road.

Blasting

115. S10320. The blasting plan should be rewritten in its entirety. All parts of S10320 should be addressed in the rewritten plan.

1. Conducted by experienced, trained, and competent persons plus 1-5 characteristics.

2. Department approved schedule for more than 5 lbs. TNT.

3. Preblasting survey.

4. Blasting only during daytime hours.

5. No unscheduled detonation.

6. Airblast controlled no more than 128 decibels.

7. Blasting not conducted within 1,000 feet of dwellings, 500 feet of disposal wells, and 500 feet of underground mine not totally abandoned.

8. Peak particle velocity.

9. Records of each blast available upon request and info. recorded.

10. Conducted to prevent injury to underground mines, ground or surface waters outside permit area.

11. Maximum weight of explosives.

116. Posting and Signs and Markers sections need to be commented upon.

Water Quality

117. S10330(2). Shell's impoundment and treatment plan should include the following:

1. A scale map showing the impoundments and the catchment area associated with each;

2. Calculations to determine the runoff volume and the peak flow, for each catchment area, to be contained in each pond and to be passed by the spillway system(s);

3. Design specifications of all impoundment structures in such detail as to allow them to be built by a construction crew;

4. Calculations of the sediment load to be deposited in the ponds over the five-year permit period;

5. Any credits towards reduction of sediment claimed under S10330(b)(c); and

6. Other items as contained in S10330(2) and (3).

   Shell should commit to the effluent limitations contained in S10330(3)(b).

   Shell should include a complete surface water monitoring plan as required by S10330(4).

Topsoiling

118. A plan for the removal of topsoil to a proper depth should be submitted in the form of a topsoil stripping depth map and narrative. Such a map shall show to what depth each horizon or lift shall be taken.

Revegetation

119. Page G. -1 The first paragraph must be rewritten to more accurately address the requirements of Section 12 of the Act.

120. Page G. - 1 The last two paragraphs. Statements should be added to these two paragraphs stating that any changes in the seed mixture or seeding rate would be subject to approval by the Department. If the note at the bottom of Page G. 4 applies to all mixtures and to the aforementioned paragraphs, it should be so stated.

121. Page G. -2 Four of the 15 pounds of seed for Area 2 are likely to be unavailable. Rather than increasing the other species to make up for unavailable species (thus decreasing the diversity) alternate species should be proposed. Alternate species should be proposed for all mixtures for species which would likely be difficult to obtain.

122. Legumes should be incorporated into all of the mixtres to increase the nitrogen in the soil.

123. A definite native forb mixture should be developed based on what is presently available.

124. A definite seedling transplant plan should be submitted for shrub and tree species best suited to seedling propagation, for example, skunkbush sumac, Ponderosa pine, and Rocky Mountain juniper. Based on work at other mines, it appears that tubling transplants are the best method for transplanting seedlings. A commitment is needed

for an approximate stocking rate and number of acres to be replanted based on the premining vegetation survey.

125. A plan should be submitted showing the selective placement of coarse textured overburden and soils (scoria and sandstone) on to which Ponderosa pine and skunkbush sumac will be planted. Locations with favorable aspects should be chosen and shown on a map.

126. A more detailed description of the method of broadcast seeding is needed. What method is proposed to spread the seed, and what method will be used to cover the seed?

127. Page G-5 The last paragraph. The statement is made that a rangeland drill will be used on rougher terrain; what kind of drill will be used on smooth level terrain?

128. If there are any areas qualifying as prime farmland 26-2.10(10)-S10350(2) should be addressed.

129. Page G-7 Paragraph G.3. A statement is needed that the vegetative cover will be of the same seasonal variety native to the area of disturbed land.

130. Positive commitments are needed addressing the following sub-sections of 26-2.10(10)-S10350:(6) consultation with state and federal wildlife agencies; (7) forest requirements.

131. Page G-7 Paragraph G.6. The rates given in table 1 must be the exact rate. The statement that the seeding rate will approximate the given rates is unacceptable.

132. A statement that the area will be protected from grazing until the seedlings have been established and can sustain managed grazing. The regulatory authority in consultation with the permittee and the landowner or in concurrence with the governmental agency having jurisdiction over the surface, shall determine when the revegetated area is ready for livestock grazing.

133. Page G-9 Paragraph G.12. A cover crop of small grains, grasses, and/or legumes must be seeded on all areas of disturbed land to control erosion until an adequate permanent cover is established. The referenced mixture is well suited for temporary reclamation areas but is not acceptable as a cover crop.

134. A statement is needed that when rills or gullies that would preclude the successful establishment of vegetation or the achievement of the postmining land use form in regraded topsoil and overburden materials, additional regrading or other stabilization practices will be required before seeding and planting as specified in section S10310 of this subchapter.

135. There appears to be confusion over what would be required for a grazing system. Prior to bond release, the Department may require livestock grazing. The system used would likely be the system that would be used by the postmining land manager, or it may be for selected intervals to gauge the vegetation response. Paragraph G.15 should be reworded accordingly.

136. A commitment is needed that all topsoil piles will be seeded during the first appropriate season. A mixture must also be specified. The mixture for temporary reclamation would be acceptable for this purpose.

137. A description and map of the reference area and a description of the monitoring plan should be submitted.

Bonding

138. Section 6, (5)(b). The permit application narrative should address the subject of surface and underground mining activities, old or new, on or adjacent to the area to be submitted.

139. Section 6(6)(g). A map showing mine facilities (like plate 10, Vol. III) should include a refuse area, if such is planned. If none is planned, a statement to that effect should be included in the narrative.

140. Section 6(6)(c). A permit or bonding map at a scale of 1" to 500', printed on paper, showing the areas bonded at the "mining", "facilities", and "associated disturbance" levels of bonding, and their acreages, should be submitted. Deleted from the areas shown on the bonding overlay should be all unnecessary associated disturbance areas:

1. To the east of the line 2,657,500E (see Plate 10, Vol. III).

2. The entire area west of the South Pit and South of the Northwest Pit except for rail loop and pond.

3. The area north of the Northwest Pit. Additional areas to be bonded at the facilities level would be the "rail loop" pond and all roads other than ramp roads. This includes the relocated county road. Additional areas to be bonded at the associated disturbance level would be "rights-of-way" of powerlines, and topsoil storage areas.

141. Section 6(7). Shell should submit a more detailed breakdown on the estimated costs of backfilling and reclamation using the

format of the Department's guidelines and assuming a worst-case condition of:

a. The pit or pits at their largest volume;

b. the largest area disturbed and not satisfactorily reclaimed;

c. the facilities at their greatest configuration and requiring removal and disposal, and reclamation of the lands they occupy. Facilities would include, but not be limited to, buildings and other structures, ponds, ditches, the railroad loop, etc.

142. Shell should recognize that on a worst-case basis, for example, the Department estimates about 25 million cubic yards of spoils will be stored at the end of year 2 in the spoil stockpile area, and at an esimtated $1.00 per cubic yard haulage cost, it would cost $25 million to fill the pit.

143. Settling is a phenomenon that is known to occur at existing surface mines in Montana at differential rates. Due to the extreme depth of the proposed Shell mine it is possible that settling could cause real problems during the reclamation process. The Department, therefore, asks that Shell commit to a precise surface settling study to be conducted as mining and reclamation proceed. It is expected that permanent reference points would be located on the reclaimed surface and surveyed in quarterly from stable benchmarks off the disturbed area.

144. On page C.1.14 it is stated that final grading of the railroad loop and road cuts and fills will "deviate slightly" from the original contours. A map should be submitted showing the final regraded contours for the roads and the railroad loop.

145. Prior to Department approval of the road relocation, Shell must obtain county and any other state approval.

Many of the deficiencies with your application were caused by the new requirements of the federal laws. Please feel free to contact this office for further definition and discussion of the deficiencies.

Sincerely,

Richard Juntunen
Coal Bureau Chief
Reclamation Division

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APPENDIX B.--Selected overburden analyses

Nitrate - Three drill holes (OB-4, OB-7, and OB-8) contain strata in which nitrate levels exceeded Federal Drinking Water Standards (10 ppm). In two of the test holes (OB-7 and OB-8), the high nitrate concentrations occurred at or near the surface. In the third test hole (OB-4) the top two hundred feet of overburden contained high nitrate concentrations, some of which exceeded Federal Livestock Standards (50 ppm). Nitrate concentrations in the overburden from 10 to 90 feet in depth, mostly porcelanite, exceeded 200 ppm.

Soluble salts - All of the drill holes intercepted saline strata in which the electrical conductivity exceeded the State suspect level. Five of the drill holes (OB-1, OB-3, OB-4, OB-7, and OB-8) encountered saline layers near the surface. All of the test holes encountered saline layers at depth. Soils having an electrical conductivity greater than 4.0 mmhos/cm are considered saline, and may restrict crop yields (Richards, 1954). Above an electrical conductivity of 8 mmhos/cm only tolerant crops provide a satisfactory yield. Overburden containing highly saline concentrations of soluble salts (-8.0 mmhos/cm) were located as follows:

The State suspect level for soluble salts if 4-6 mmhos/cm.

Drill hole No.	Interval (ft) From	-	To	Electric conductivity mmhos/cm
OB-1-----	4	-	10	11.8
OB-4-----	4	-	10	9.2
OB-4-----	10	-	20	11.2
OB-4-----	20	-	26	14.2
OB-4-----	26	-	36	17.6
OB-4-----	36	-	40	18.5
OB-4-----	40	-	50	15.0
OB-4-----	50	-	60	15.7
OB-4-----	60	-	70	14.0
OB-4-----	70	-	80	12.2
OB-4-----	80	-	90	8.80
OB-7-----	0	-	4	8.40
OB-7-----	4	-	10	8.10
OB-7-----	18	-	22	9.00
OB-7-----	22	-	26	15.7

Highly saline overburden is found in both pit areas. The thickest layer (30 ft) of highly saline material is associated with porcelanite in drill hole OB-4.

SAR - The sodium-absorption-ratio exceeds the State suspect level in six test holes. Richards (1954) reports a high sodium hazard when the SAR value ranges from 18 to 26. Some of the higher SAR values ($\geq$ 20) are tabled below.

The State suspect level for SAR is 12.

Drill hole No.	Interval (ft) From - To	SAR	Drill hole No.	Interval (ft) From - To	SAR
OB-1-------	100 - 110	20.48	OB-7-------	258 - 270	23.89
OB-1-------	110 - 113	21.10	OB-7-------	270 - 280	27.39
OB-2-------	222 - 228	21.13	OB-7-------	280 - 290	26.81
OB-2-------	228 - 230	21.73	OB-7-------	290 - 300	39.74
OB-5-------	250 - 256	21.35	OB-7-------	300 - 304	32.36
OB-5-------	260 - 270	20.73	OB-7-------	304 - 314	23.62
OB-5-------	280 - 290	24.18	OB-7-------	318 - 320	23.58
OB-5-------	290 - 300	23.27	OB-8-------	64 - 74	21.22
OB-5-------	300 - 310	22.74	OB-8-------	74 - 80	23.33
OB-7-------	76 - 86	33.46	OB-8-------	80 - 90	25.47
OB-7-------	86 - 98	34.89	OB-8-------	90 - 100	24.00
OB-7-------	98 - 108	35.42	OB-8-------	122 - 130	23.82
OB-7-------	108 - 118	28.43	OB-8-------	130 - 140	26.30
OB-7-------	118 - 124	31.75	OB-8-------	174 - 180	24.62
OB-7-------	124 - 130	47.14	OB-8-------	180 - 190	29.56
OB-7-------	130 - 140	47.35	OB-8-------	194 - 200	37.54
OB-7-------	140 - 150	25.09	OB-8-------	200 - 210	25.60
OB-7-------	180 - 190	47.14	OB-8-------	210 - 220	25.61
OB-7-------	190 - 200	42.25	OB-8-------	220 - 230	29.00
OB-7-------	200 - 210	29.27	OB-8-------	252 - 262	34.43
OB-7-------	210 - 220	44.68	OB-8-------	262 - 272	20.63
OB-7-------	220 - 230	23.91	OB-8-------	272 - 274	21.61
OB-7-------	230 - 240	24.97	OB-8-------	302 - 309	25.35
OB-7-------	240 - 250	29.92	OB-8-------	318 - 320	33.56
OB-7-------	250 - 258	25.63	OB-8-------	320 - 322	26.21

In the northwestern part of the permit area, the overburden has lower SAR than the southern part. Drill holes OB-1 and OB-2 each intercept only a single layer in which the overburden SAR exceeded 20. The high SAR values were associated with shale layers in both test holes. Drill holes OB-3 and OB-4 contain no intervals in excess of the State suspect levels.

In the southern part of the permit area SAR values run higher. Test hole OB-5 contain several strata in which the SAR exceeds 20; in drill holes OB-7 and OB-8 most of the overburden exceeds State suspect levels, much of it has SAR values above 20. In the southern area there is no apparent relationship between lithology and SAR values.

Texture - All of the test holes within the permit area encountered strata in which the clay content exceeded 40 percent. Although commonly occurring above or below coal beds, overburden with a high clay content was found

throughout the column, near the surface, at intermediate depths, and near the base of the test hole. Some of the higher clay contents were located as follows:

The State suspect level for texture is 40 percent clay.

Drill hole No.	Interval (ft) From - To	Percent Clay	Drill hole No.	Interval (ft) From - To	Percent Clay
OB-1-------	16 - 24	52.0	OB-5-------	109 - 112	50.6
OB-1-------	46 - 50	68.0	OB-5-------	158 - 164	54.4
OB-1-------	50 - 60	64.0	OB-5-------	175 - 178	52.8
OB-1-------	60 - 70	72.0	OB-5-------	181 - 189	57.4
OB-1-------	70 - 75	59.0	OB-5-------	240 - 250	59.6
OB-1-------	75 - 80	55.0	OB-5-------	250 - 256	64.6
OB-1-------	80 - 90	50.0	OB-5-------	330 - 332	73.0
OB-1-------	110 - 113	57.0	OB-6-------	50 - 60	54.6
OB-1-------	132 - 134	51.0	OB-6-------	60 - 70	70.2
OB-1-------	150 - 155	52.4	OB-6-------	70 - 80	50.6
OB-1-------	240 - 250	54.0	OB-6-------	80 - 90	51.2
OB-2-------	24 - 28	53.0	OB-6-------	94 - 103	50.0
OB-2-------	46 - 50	57.0	OB-6-------	148 - 150	55.6
OB-2-------	60 - 70	52.6	OB-7-------	37 - 39	54.4
OB-2-------	70 - 80	55.4	OB-7-------	39 - 50	52.4
OB-2-------	80 - 88	56.6	OB-7-------	56 - 66	59.4
OB-2-------	96 - 106	53.0	OB-7-------	98 - 108	61.2
OB-2-------	182 - 192	64.0	OB-7-------	124 - 130	61.8
OB-2-------	192 - 202	66.0	OB-7-------	130 - 140	67.8
OB-2-------	222 - 228	56.4	OB-7-------	300 - 304	56.2
OB-2-------	358 - 360	50.4	OB-7-------	404 - 406	50.2
OB-3-------	38 - 40	59.4	OB-8-------	44 - 50	57.8
OB-3-------	50 - 60	64.4	OB-8-------	64 - 74	50.2
OB-3-------	70 - 74	53.4	OB-8-------	122 - 130	65.6
OB-3-------	115 - 120	50.4	OB-8-------	130 - 140	54.8
OB-4-------	190 - 196	51.4	OB-8-------	230 - 240	50.2
OB-5-------	20 - 24	51.6	OB-8-------	262 - 272	52.2
OB-5-------	42 - 46	71.6	OB-8-------	272 - 274	77.6
OB-5-------	46 - 52	70.6	OB-8-------	314 - 318	55.6
OB-5-------	84 - 94	52.6	OB-8-------	369 - 371	59.0

Zinc - All of the overburden test holes contain strata in which the zinc concentrations exceeded State suspect levels. These concentrations occurred throughout the column, from the surface in drill hole OB-3, to a depth of 426 feet in drill hole OB-7. Some of the higher zinc concentrations occurred as follows.

The State suspect level for zinc is 40 ppm.

Drill hole No.	Interval (ft) From - To	Zinc (ppm)	Drill hole No.	Interval (ft) From - To	Zinc (ppm)
OB-2-------	300 - 310	184.8	OB-7-------	37 - 39	112.0
OB-2-------	340 - 350	141.5	OB-7-------	160 - 170	103.2
OB-5-------	280 - 290	218.0	OB-7-------	420 - 426	160.0
OB-5-------	300 - 310	570.0	OB-8-------	200 - 210	185.2
OB-5-------	316 - 324	122.0	OB-8-------	220 - 230	210.0
OB-5-------	358 - 368	451.2	OB-8-------	240 - 246	360.0
OB-5-------	378 - 388	444.0	OB-8-------	380 - 386	177.6
OB-6-------	200 - 210	122.0			

In general, the higher zinc concentrations were found in overburden in the southern part of the permit area.

Molybdenum - All of the overburden test holes contained strata in which molybdenum concentrations exceed State suspect levels. In most cases all of the test hole overburden exceeded the suspect level. The highest molybdenum concentrations in each drill hole are tabled below.

The State suspect level for molybdenum is 0.3 ppm

Drill hole No.	Interval (ft) From - To	Molybdenum (ppm)
OB-1-------	230 - 240	4.75
OB-2-------	202 - 212	7.94
OB-3-------	38 - 40	6.20
OB-4-------	120 - 126	6.54
OB-5-------	240 - 250	5.41
OB-6-------	40 - 50	7.93
OB-7-------	66 - 76	10.07
OB-8-------	116 - 122	7.66

Except for test hole OB-1, the highest molybdenum concentrations were associated with finer textured rock, shale or siltstone.

Nickel - All of the overburden test holes contained intervals in which the nickel concentrations exceeded State suspect levels. In each case, most of the column exceeded the suspect levels, although near surface strata (10-30 ft) and a few strata at depth did not contain excessive concentrations. Some of the higher nickel concentrations occurred as shown in the following table.

The State suspect level for nickel is 1.0 ppm.

Drill hole No.	Interval (ft) From - To	Nickel (ppm)	Drill hole No.	Interval (ft) From - To	Nickel (ppm)
OB-1-------	46 - 50	9.10	OB-5-------	84 - 94	5.56
OB-1-------	50 - 60	8.40	OB-5-------	94 - 98	6.20
OB-1-------	60 - 70	10.54	OB-5-------	102 - 106	5.00
OB-1-------	75 - 80	7.66	OB-5-------	158 - 164	5.44
OB-1-------	80 - 90	5.66	OB-5-------	181 - 189	5.00
OB-2-------	46 - 50	5.00	OB-5-------	236 - 240	5.00
OB-2-------	60 - 70	5.88	OB-6-------	36 - 40	5.68
OB-2-------	80 - 88	7.32	OB-6-------	50 - 60	5.20
OB-2-------	182 - 192	7.40	OB-6-------	60 - 70	6.86
OB-2-------	254 - 262	6.00	OB-6-------	110 - 114	5.88
OB-3-------	38 - 40	8.40	OB-6-------	114 - 118	5.88
OB-3-------	40 - 50	10.00	OB-7-------	22 - 26	5.00
OB-3-------	50 - 60	7.64	OB-7-------	98 - 108	5.24
OB-3-------	115 - 120	5.10	OB-8-------	64 - 74	5.34
OB-4-------	20 - 26	6.96	OB-8-------	240 - 246	5.10
OB-4-------	126 - 136	5.00	OB-8-------	252 - 262	5.00
OB-5-------	78 - 81	6.20	OB-8-------	262 - 272	6.66

In general, the higher nickel concentrations were found in finer textured overburden. The few strata in which concentrations fell below State suspect levels were commonly coarser textured overburden.

Cadmium - In all of the test holes most of the overburden contained cadmium concentrations equal to or in excess of 0.1 ppm. However, concentrations remained at the lower end of the suspect range. The highest cadmium concentrations (0.35 ppm) occurred in sandstone and siltstone strata found in drill holes OB-4 and OB-7.

APPENDIX C.--Chemical analyses of groundwaters in the Youngs Creek-Squirrel Creek headwaters area (mg/L)

[Source: Hedges, Van Voast, and McDermott, 1976; coal bed designations from Shell Oil Company]

Location	Temperature (°C)	Silica	Iron	Manganese	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Carbonate	Sulfate	Chloride	Fluoride	Nitrogen/ nitrate	Dissolved solids	Total hardness as $CaCO_3$	Total alkalinity as $CaCO_3$	Sodium-Adsorp- tion-ratio	Specific conductance	pH
Waters from alluvium																				
9S.38E. 24CABC[1]	7.0	18.7	0.02	0.07	110.0	220.0	155	12.0	500	0.0	1,066	6.6	0.2	0.23	1,836	1,193	410	2.0	2,180	7.8
9S.38E. 25DACC	9.5	21.8	0.14	0.01	91.0	98.0	86	9.4	592	0.0	321	4.9	0.7	1.59	928	634	485	1.5	1,370	7.9
9S.39E. 20BCCD	7.0	14.5	0.28	.01	150.0	203.0	129	---	617	0.0	939	10.0	0.4	0.63	1,762	1,210	506	1.6	2,280	8.0
9S.39E. 20BCCD	7.0	14.5	0.22	.01	145.0	179.0	94	---	561	0.0	814	5.7	0.4	0.90	1,540	1,099	460	1.2	2,000	8.0
Waters from the G coal bed																				
9S.38E. 10CCAA	14.5	11.0	0.41	0.04	74.0	139.0	215	---	1,016	0.0	332	29.0	0.7	0.75	1,310	755	833	3.4	1,890	7.5
9S.39E. 29ABAA	15.0	10.4	0.12	.01	8.4	6.4	1,025	8.3	1,758	0.0	829	10.0	2.9	0.02	2,767	47	1,442	65.0	3,990	8.3
Waters from the G and M coal beds combined																				
9S.39E. 33DBBC	15.8	11.3	0.10	0.01	4.0	1.5	424	9.9	866	0.0	186	9.9	1.2	0.36	1,075	16	710	46.0	1,740	8.0
Waters from the M coal bed																				
8S.39E. 32DBBC	14.0	9.7	0.06	.01	2.0	1.0	310	4.8	776	0.0	47	1.9	0.3	0.39	760	9	637	44.0	1,190	8.1
9S.38E. 01AADC	14.2	10.1	0.04	.01	5.8	4.7	265	8.7	703	0.0	37	7.7	0.3	0.56	686	34	577	20.0	1,080	7.9
9S.38E. 10CCAA	15.0	8.7	0.12	.01	4.6	4.9	426	4.5	984	0.0	135	5.1	2.3	0.88	1,077	31	807	33.0	1,680	7.8
9S.38E. 22DADC	--	14.8	.01	.01	18.0	45.0	154	7.0	351	22.0	230	3.6	0.8	1.49	674	233	325	4.4	944	8.5
9S.38E. 23CDAD	--	15.2	.01	.01	12.0	48.0	521	9.3	623	35.0	756	4.9	0.5	3.48	1,723	229	596	15.0	2,150	8.8
9S.38E. 24BBBC	12.8	12.6	.01	.01	8.8	2.9	377	4.2	1,017	9.0	17	4.2	3.4	0.16	940	34	849	28.0	1,490	3.4
9S.38E. 24CDAD	12.5	17.4	8.4	0.11	99.0	208.0	106	12.0	417	0.0	975	7.6	0.3	0.02	1,639	1,116	342	1.4	1,980	8.1
9S.38E. 25BCBA	12.0	13.1	0.1	.01	5.6	2.4	445	3.7	771	24.0	294	3.9	2.1	1.69	1,181	24	631	39.0	1,600	8.5
9S.38E. 25CBDC	--	14.3	.01	.01	30.0	113	450	9.7	654	24.0	907	7.9	1.4	1.29	1,885	548	576	8.4	2,440	8.4
9S.38E. 26ABAB	14.0	12.4	0.02	.01	3.5	0.2	376	2.9	569	58.0	249	5.1	1.2	1.08	992	10	653	52.0	1,370	9.1
9S.38E. 27ACBB	--	18.7	.01	0.02	55.0	45.0	20	9.1	312	17.0	70	2.8	1.4	0.45	393	321	284	0.5	638	8.6
Waters from the O coal bed																				
9S.38E. 24CABC[3]	--	6.8	.01	.01	4.8	1.9	440	4.1	874	72.0	120	4.3	2.2	1.78	1,094	20	837	43.0	1,560	9.0
9S.38E. 27ACBB	11.1	7.5	.01	.01	4.4	1.6	365	2.9	810	79.0	21	4.8	3.1	0.14	888	18	796	38.0	1,460	9.4
9S.38E. 29BBDD	10.5	8.3	0.18	.01	5.0	7.3	638	5.8	926	0.0	630	11.6	1.7	0.07	1,764	43	759	42.0	2,650	8.0

[1] Domestic and stock-water well; H. Schreibles
[2] Water from M coal mixed with leakage from shallower sources
[3] Domestic water well, currently abandonned; H. Schreibles

APPENDIX D.--Summary of the concentration of trace elements in suspended particulate

(Micrograms of trace element per cubic meter of filtered air)

Trace element	Oct.-Dec. 1975		Jan.-Dec. 1976		Jan.-Dec. 1977	
	Mean	Max	Mean	Max	Mean	Max
Sulfate	*	1.1	*	7.4	2.4	4.6
Beryllium	*	<0.001	*	<0.001	*	<0.001
Lead	*	0.08	*	0.08	*	<0.05
Cadmium	0.006	0.10	*	0.008	*	0.003
Vanadium	*	<0.05	*	<0.05	*	<0.05
Iron	*	0.25	0.14	0.58	0.09	0.42
Zinc	0.138	0.574	0.01	0.06	*	0.04
Calcium	0.781	1.126	1.18	7.31	*	0.79
Strontium	*	0.014	*	<0.01	*	0.11
Arsenic	*	0.016	*	<0.008	*	<0.008
Mercury	*	0.009	*	0.005	*	<0.005

*No statistics are compiled when more than 25 percent of the values are less than the minimum detectable value.

< Denotes that concentration is less than the indicated value which is the minimum detectable value.

NOTE: Montana Air Quality Standards

Suspended sulfate
4 micrograms per cubic meter of air maximum allowable annual average
12 micrograms per cubic meter of air, not to be exceeded over 1 percent of the time

Lead
5.0 micrograms per cubic meter of air, 30-day average

Beryllium
0.01 micrograms per cubic meter of air, 30-day average

APPENDIX E.--Soil capability groups defined

The Soil Conservation Service has developed a system of capability groups which show, in a general way, the suitability of soils for agricultural use.

Capability group III, IV, VI and VIII are mapped in the Pearl permit area. These are defined as follows:

Class III. These soils have severel limitations that reduce the choice of crops or require special conservation practices, or both.

Class IV. Similar to Class III soils, but with very severe limitations and/or requiring very careful management.

Class VI. These soils have severe limitations making them generally unsuited to cultivation and limit their use largely to pasture, range or wildlife habitat.

Class VIII. These soils and land forms have limitations that preclude their use for crops or rangeland and restrict their use to recreation, wildlife habitat, watershed or esthetic purposes.

Within the various capability classes, subclasses are designated by adding a small letter c, e, s or w to the Roman numeral; for example, IVe. Within the permit area, subclasses "e" and "w" are represented, indicating that the main limitations are risk of erosion ("e"), and a high water table ("w"). Excess water affects only nine acres. Erosion risk is a function of soil texture and the characteristic high intensity precipitation events of the area.

APPENDIX F.--Species list for the Pearl area

Grasses and grass-like plants	
Agropyron albicans----------	Wheatgrass
Agropyron caninum-----------	Pubescent wheatgrass
Agropyron cristatum---------	Crested wheatgrass
Agropyron smithii-----------	Western wheatgrass
Agropyron spicatum----------	Bluebunch wheatgrass
Andropogon gerardii---------	Big bluestem
Andropogon scoparius--------	Little bluestem
Aristida fendleriana--------	Fendler's three awn
Aristida longiseta----------	Red three awn
Bouteloua gracilis----------	Blue grama
Bromus inermis--------------	Smooth brome
Bromus japonicus------------	Japanese brome
Bromus tectorum-------------	Cheatgrass
Calamagrostis montanensis---	Plains reedgrass
Calamovilfa longifolia------	Prairie sandreed
Carex eleocharis------------	Needleleaf sedge
Carex filifolia-------------	Threadleaf sedge
Carex spp.------------------	Sedge
Dactylis glomerata----------	Orchard grass
Echinochloa crusgalli-------	Barnyard grass
Elymus cinereus-------------	Giant wild rye
Festuca idahoensis----------	Idahoe fescue
Hordeum jubatum-------------	Foxtail barley
Juncus spp.-----------------	Rush
Koeleria cristata-----------	Prairie junegrass
Muhlenbergia asperifolia----	Scratchgrass
Munroa squarrosa------------	False buffalograss
Oryzopsis hymenoides--------	Indian ricegrass
Phalaris arundinacea--------	Canary grass
Phleum pratense-------------	Timothy
Poa pratensis---------------	Kentucky bluegrass
Poa secunda-----------------	Sandberg bluegrass
Poa spp.--------------------	Bluegrass
Scirpus americanus----------	American bulrush
Sitanion hystrix------------	Squirreltail
Stipa comata----------------	Needle-and-thread
Stipa viridula--------------	Green needlegrass
Vulpia octoflora------------	Six-weeks fescue

APPENDIX F.-- Species list for the Pearl area--Continued

Trees, shrubs, halfshrubs, vines, and cacti	
Acer negundo----------------	Box elder
Artemisia cana--------------	Silver sagebrush
Artemisia frigida-----------	Fringed sagewort
Artemisia ludoviciana-------	Cudweed sagewort
Artemisia tridentata--------	Big sage
Atriplex nuttallii----------	Nuttall saltbush
Chrysothamnus nauseosus-----	Rubber rabbitbrush
Clematis ligusticifolia-----	Western virgin's bower
Crataegus columbiana--------	Columbia hawthorn
Crataegus succulenta--------	Fleshy hawthorn
Eurotia lanata--------------	Winterfat
Fraxinus americana----------	White ash
Gutierrezia sarothrae-------	Broom snakeweed
Juniperis horizontalis------	Creeping juniper
Juniperus scopularum--------	Rocky Mountain juniper
Opuntia fragilis------------	Brittle pricklypear cactus
Opuntia polyacantha---------	Plains pricklypear cactus
Pinus ponderosa-------------	Ponderosa pine
Populus deltoides-----------	Cottonwood
Prunus americana------------	Wild plum
Prunus virginiana-----------	Chokecherry
Rhus trilobata--------------	Skunkbush sumac
Ribes aureum----------------	Golden current
Ribes cereum----------------	Western red current
Ribes setosum---------------	Spiny current
Rosa arkansana--------------	Prairie rose
Rosa woodsii----------------	Woods rose
Salix amygdaloides----------	Peachleaf willow
Salix spp.------------------	Willow
Symphoricarpos occidentalis-	Snowberry
Yucca glauca----------------	Yucca

APPENDIX F.--Species list for the Pearl area - Continued

Forbs	
Achillea millefoilium-------	Yarrow
Agoseris glauca-------------	False dandelion
Allium textile--------------	Wild onion
Ambrosia psilostachya-------	Western ragweed
Anemone patens--------------	Pasque flower
Antennaria dimorpha---------	Low pussytoes
Antennaria neglecta---------	Field pussytoes
Antennaria parvilfolia------	Small-leaf pussytoes
Antennaria rosea------------	Rose pussytoes
Apocynum adnrosaemifolium---	Spreading dogbane
Aribis holboellii-----------	Holboell rockcress
Arctium minus---------------	Smaller burdock
Arenaria hookeri------------	Hooker sandwort
Artemisia campestris--------	Western sagebrush
Asclepias speciosa----------	Showy milkweed
Asclepias verticillata------	Whorld milkweed
Aster spp.------------------	Aster
Astragalus bisulcatus-------	Two grooved milkvetch
Astragalus crassicarpus-----	Groundplum milkvetch
Astragalus spp.-------------	Milkvetch
Balsamorhiza sagittata------	Balsam root
Besseya wyomingensis--------	Kittentail
Calochortus nuttallii-------	Sego lily
Camelina microcarpa---------	Littlepod falseflax
Campanula rotundifolia------	Harebell
Cerastium arvense-----------	Field chickweed
Chenopodium album-----------	Lambsquarters
Chrysopsis villosa----------	Gold aster
Cicuta douglasii------------	Waterhemlock
Circium arvense-------------	Canada thistle
Cirsium undulatum-----------	Wavy-leaved thistle
Cirsium vulgare-------------	Bull thistle
Cleome serrulata------------	Bee plant
Collinsia parviflora--------	Blue lips
Collomia linearis-----------	Narrow leaved collomia
Comandra umbellata----------	Sandlewood
Convolvulus arvensis--------	Field bindweed
Crypthantha bradburiana-----	Miners candle
Cynoglossum officinale------	Hounds tongue
Delphinium bicolor----------	Larkspur

APPENDIX F.--Species list for the Pearl area - Continued

Forbs - Continued	
Descurainia pinnata---------	Tansy mustard
Epilobium glandulosum-------	Glandular willow-herb
Erigeron pumilus------------	Fleabane
Erigeron spp.---------------	Fleabanes
Eriogonum annuum------------	Annual eriogonum
Eriogonum flavum------------	Yellow eriogonum
Eriogonum pauciflorum-------	none
Erysimum asperum------------	Plains wallflower
Euphorbia robusta-----------	Spurge
Gaillardia aristata---------	Blanket flower
Galium aparine--------------	Bedstraw
Gaura coccinea--------------	Scarlet gaura
Geum triflorum--------------	Old man's whiskers
Glycyrrhiza lepidota--------	Wild licorice
Grindelia squarrosa---------	Curlcup gumweed
Haplopappus spinulosus------	Spiny goldenweed
Hedeoma hispida-------------	Rough false pennyroyal
Helianthus annuus-----------	Annual sunflower
Helianthus petiolaris-------	Prairie sunflower
Heracleum lanatum-----------	Cow parsnip
Heuchera parvifolia---------	Little leaf allum
Hymenoxys acaulis-----------	none
Lactuca pulchella-----------	Blue lettuce
Lactuca serriola------------	Prickly lettuce
Lappula redowskii-----------	Western sticktight
Lepidium densiflorum--------	Prairie pepperweed
Lesquerella alpina----------	Alkaline bladderpod
Leucocrinum montanum--------	Starlily
Liatris punctata------------	Gay feather
Linum perenne---------------	Blue flax
Linum rigidum---------------	Yellow flax
Lithospermum incisum--------	Narrow leaf gromwell
Lithospermum ruderale-------	Western gromwell
Lomatium orientale----------	Eastern lomatium
Lupinus argenteus-----------	Silvery lupine
Lygodesmia juncea-----------	Wire rush/skeleton plant
Medicago sativa-------------	Alfalfa
Melilotus alba--------------	White sweetclover
Melilotus officinalis-------	Yellow sweetclover
Mentzelia decapetala--------	Sand lily

APPENDIX F.--Species list for the Pearl area - Continued

Forbs - Continued	
Mertensia oblongifolia------	Oblong-leaf bluebell
Microseris cuspidata--------	False dandelion
Monarda fistulosa-----------	Horse mint
Monolepis nuttalliana-------	Nuttall monolepis
Musineon divaricatum--------	none
Oenothera albicaulis--------	Whitestem evening primrose
Oenothera caespitosa--------	Tufted evening primrose
Orthocarbus luteus----------	Owl's clover
Oxytropis lambertii---------	Purple locoweed
Oxytropis sericea-----------	White locoweed
Penstemon albidus-----------	White beardtongue
Penstemon nitidus-----------	Waxleaf penstemon
Petalostemon candidum-------	White prairie clover
Petalostemon purpureum------	Purple prairie clover
Phacelia hastata------------	Scorpion weed
Phlox hoodii----------------	Hoods phlox
Plantago purshii------------	Wooly plaintain
Polygonum bistortoides------	Western bisort
Polygonum convolvulus-------	Buckwheat bindweed
Psoralea argophylla---------	Silverleaf scurfpea
Psoralea esculenta----------	Breadroot scurfpea
Psoralea tenuifolia---------	Slim flower scurfpea
Ratibida columnifera--------	Coneflower
Rumex crispus---------------	Sour dock
Salsola kali----------------	Russian thistle
Senecio canus---------------	Wooly groundsel
Senecio integerrimus--------	Lambstongue groundsel
Sisymbrium altissimum-------	Tumble mustard
Solanum triflorum-----------	Cut-leaved nightshade
Solidago missouriensis------	Prairie goldenrod
Solidago mollis-------------	Goldenrod
Sonchus asper---------------	Spiny sow-thistle
Sphaeralcea coccinea--------	Scarlet mallow
Taraxacum officinale--------	Dandelion
Thalictrum occidentale------	Meadow rue
Thalaspi arvense------------	Fanweed
Townsendia hookeri----------	Townsendia
Tragopogon dubius-----------	Yellow goatsbeard
Typha latifolia-------------	Cattail
Urtica dioica---------------	Nettle

APPENDIX F.--Species list for the Pearl area - Continued

Forbs - Continued	
Verbena bracteata-----------	Prostrate vervain
Vicia americana-------------	American vetch
Xanthium strumarium---------	Cockleburr
Zigadenus venonesus---------	Death camas

APPENDIX G.--Floral descriptions of plant communities in the Pearl area

1. Big sagebrush-grass types

This community type contains two subtypes, the big sagebrush-bluebunch wheatgrass subtype and the big sagebrush-western wheatgrass subtype. In the former, big sagebrush is the dominant shrub with varying amounts of rubber rabbitbrush, rose, winterfat, skunkbush, occasionally juniper, and broom snakeweed. Bluebunch wheatgrass normally dominates while prairie junegrass, western wheatgrass, needle-and-thread, blue grama, and Indian ricegrass vary in coverage. Big sagebrush dominates other shrubs such as rose, winterfat, juniper, and broom snakeweed. Western wheatgrass is the dominant grass. Annual brome grasses vary in coverage, depending on past disturbance, but are present in all stands.

In the latter subtype, green needlegrass is common where overgrazing has not occurred or where pastures have been rested for 2 or more years. Other grasses are prairie junegrass, native bluegrass, needle-and-thread, and threadleaf sedge. Bluebunch wheatgrass may also occur where the two big sagebrush subtypes intergrade and in areas where there is considerable topographic variance. This subtype has been separated into three distinct phases by the occurrence of co-dominant species: Prairie junegrass phase, Winterfat phase, and Indian ricegrass phase.

2. Silver sagebrush-grass type

Silver sagebrush is the dominant shrub with lesser amounts of big sagebrush, rabbitbrush and broom snakeweed. Western wheatgrass is the dominant grass. In those stands in good condition green needlegrass is common. Stands in poorer condition contain prairie junegrass, bluegrasses, and annual brome grasses.

3. Skunkbush-grassland type

The dominant shrub is skunkbush; other shrubs are big sagebrush, silver sagebrush, rose, chokecherry and broom snakeweed. An occasional pine or juniper is also found. Bluebunch wheatgrass is the dominant grass. On southerly aspects bluebunch wheatgrass may account for nearly 100 percent of the perennial grass cover; on northerly aspects prairie junegrass, green needlegrass, needle-and-thread,and threadleaf sedge are common.

4. Native grass type

Three subtypes of the native grass type occur in the permit area: the bluebunch wheatgrass/prairie junegrass subtype, the needle-and-thread/western wheatgrass subtype, and the annual grass subtype. The first of these includes western wheatgrass, native bluegrass, green needlegrass, and needle-and-thread. Common forbs are Hood's phlox, erigeron, purple prairie clover, scarlet globemallow, scurfpea, and salsify. Broom snakeweed and annual bromes are abundant in overgrazed areas.

The needle-and-thread/western wheatgrass subtype contains several perennial grasses including needle-and-thread, western wheatgrass, blue grama, bluebunch wheatgrass, green needlegrass, Indian ricegrass, junegrass, and prairie reedgrass.

This subtype is dominated by invading weedy species of annuals, due to overgrazing. Increased precipitation and decreased grazing use appear to enable this community to recover from abuse (Culwell, oral communication, 1979), as indicated by an increase in the western wheatgrass canopy cover.

5. Riparian type

Three phases of this type are present on the permit area. Box elder, chokecherry, plum, cottonwood, and hawthorn are dominant deciduous trees. Willows, rose, and snowberry are common shrubs in the deciduous tree phase.

Rushes, sedges, and perennial grasses vary in dominance from area to area within the grass/sedge phase, depending on depth to water and past use.

In the deciduous shrub phase western wheatgrass, Kentucky bluegrass, and green needlegrass are common grasses.

6. Rare and endangered species

Spreading yellow cress (*Rorippa calycina*) is designated as "threatened" in Montana and could inhabit sites along the Tongue River. In Montana it is known to exist on or near sandy river bottoms of the Yellowstone River from Fort Sarpy to Fort Union (Hitchcock, 1961).

APPENDIX H.--AUM's, Pearl area, Montana

Transect	Perennial grass production (lbs/acre)	50-percent utilization (lbs/acre)	AUMS/acre[1]	Acres/AUM
BIG SAGEBRUSH-GRASSLAND				
Big sagebrush/bluebunch wheatgrass				
PV-4 Artr/Agsp----	344.74	172.37	0.23	4.3
PV-7 Artr/Agsp----	493.82	246.91	0.33	3.0
PV-8 Artr/Agsp----	699.09	349.55	0.47	2.1
PV-12 Artr/Agsp----	370.77	185.38	0.25	4.0
PV-15 Artr/Agsp----	506.66	253.33	0.38	2.6
Big sagebrush/western wheatgrass				
PV-1 Artr/Agsm----	609.03	304.53	0.41	2.4
PV-3 Artr/Agsm----	131.79	65.90	0.09	11.1
PV-13 Artr/Agsm----	526.46	263.23	0.35	2.8
PV-21 Artr/Agsm----	422.84	211.42	0.28	3.6
PV-24 Artr/Agsm----	395.20	197.60	0.26	3.8
SKUNKBUSH-GRASSLAND				
PV-10 Rhtr/Agsp----	180.66	90.33	0.12	8.3
PV-18 Rhtr/Agsp----	214.72	107.36	0.14	7.1
SILVER SAGEBRUSH-GRASS				
PV-9 Arca/Agsm----	165.77	82.88	0.11	9.1
PV-23 Arca/Agsm----	472.24	236.12	0.31	3.2
NATIVE GRASS				
Bluebunch wheatgrass/junegrass				
PV-2 Agsp/Kocr----	593.16	292.58	0.50	2.5
PV-5 Agsp/Kocr----	1,087.87	543.94	0.72	1.4
PV-22 Agsp/Kocr----	153.91	76.95	0.10	10.0
PV-26 Agsp/Kocr----	377.28	188.64	0.25	4.0
Needle-and-thread/western wheatgrass				
PV-19 Stco/Agsm----	436.13	218.06	0.29	3.4
PV-20 Stco/Agsm----	427.57	213.78	0.28	3.6
Annual grass				
PV-14 Annual Grass-	859.06	429.53	0.57	1.8
PONDEROSA PINE				
PV-6 Pipo/Agsp----	268.40	134.20	0.18	5.6
PV-16 Pipo/Agsp----	39.06	19.53	0.03	33.3
PV-17 Pipo/Agsp----	130.72	65.36	0.09	11.1
RIPARIAN				
PV-11 Riparian-----	173.52	86.76	0.12	8.3
PV-25 Riparian-----	1814.07	907.04	1.21	0.8

[1]Assumes 25 lbs/day/animal.

APPENDIX I.--Wildlife species list - Pearl area

[Source: Westech, 1977; Mikal, S.; *These birds were present on only 1 or 2 days and were probably just passing through the habitat. **These birds were migrants]

Birds	
American goldfinch----------	Spinus tristis
American kestrel-----------	Falco sparverius
American pigeon ------------	Mareca americana
American redstart-----------	Setophaga ruticilla
Barn swallow----------------	Hirundo rustica
*Belted kingfisher-----------	Megaceryle alcyon
Black-billed cuckoo---------	Coccyzus erythropthalmus
Black-billed magpie---------	Pica pica
Black-capped chickadee------	Parus atricapillus
Black-headed grosbeak-------	Pheucticus melanocephalus
Brewer's sparrow------------	Spizella breweri
Brown-headed cowbird--------	Molothrus ater
Brown thrasher--------------	Toxostoma rufum
Canada goose----------------	Brantes canadensis
Catbird---------------------	Dumetella carolinensis
Chestnut-collared longspur--	Calcarius ornatus
Chipping sparrow------------	Spizella passerina
Cliff swallow---------------	Petrochelidan pyrrhonota
Common crow-----------------	Corvus grachyrhynchos
Common flicker--------------	Colaptes auratus
Common grackle--------------	Quiscalus quiscula
Common nighthawk------------	Chordeiles minor
*Common snipe----------------	Capella gallinago
Cooper's hawk---------------	Accipiter cooperii
Downy woodpecker------------	Dendrocopos pubescens
Eastern kingbird------------	Tyrannus tyrannus
Gadwall---------------------	Anas strepera
Golden eagle----------------	Aquila chrysaetos
Grasshopper sparrow---------	Ammodramus savannarum
Gray partridge--------------	Perdix perdix
*Grayheaded junco------------	Junco caniceps
Great horned owl------------	
**Green-tailed towhee---------	Pipilo chlorurus
Hairy woodpecker------------	Dendrocopos villosus
Horned lark-----------------	Eremophila alpestris

APPENDIX I.--Wildlife species list - Pearl area - Continued

Birds - Continued	
House wren-------------------	Trogolodytes aedon
Indigo bunting--------------	Passerina cyanea
Killdeer--------------------	Charadrius vociferus
Lark bunting----------------	Calamospize melanocorys
Lark sparrow----------------	Chondestes grammacus
Lazuli bunting--------------	Passerina amoeha
Lease flycatcher------------	Asyndesmus lewis
*Lewis' woodpecker-----------	Asyndesmus lewis
Long-eared owl--------------	Asio otus
Mallard---------------------	Anas platyrkynalios
Marsh hawk------------------	Circus cyaneus
McCown's longspur-----------	Rhynchophanes mecownii
Mountain bluebird-----------	Sialia currucoides
Mourning dove---------------	Zehaidura macroura
Northern oriole-------------	Icterus galbula
Pintail---------------------	Anas acuta
Prairie falcon--------------	Falco mexicanus
Red-tailed hawk-------------	Buteo jamaicensis
*Red-eyed vireo--------------	Vireo olivaceus
Red-headed woodpecker-------	Melanerpes erythrocephalys
Red-wing blackbird----------	Agelaius phoeniceus
Ring-necked pheasant--------	Phasianus colchicus
Robin-----------------------	Turdus migratorius
Rock wren-------------------	Salpinctes obsoletus
Rough-legged hawk-----------	Buteo lag-pus
Rufous-sided towhee---------	Pipilo erythrophthalmus
Sage grouse-----------------	Centrocerus urophasianus
Sage thrasher---------------	Oreoscoptes montanus
*Say's phoebe----------------	Sayornis saya
Short-eared owl-------------	Asio flammeus
Sharp-tailed grouse---------	Pedioecetes phasianellus
Snow goose------------------	Chen hyperborea
*Solitary vireo--------------	Vireo solitarius
Song sparrow----------------	Melospiza melodia
Sora------------------------	Prozana cardina
Starling--------------------	Sturnus vulgaris
Swainson's thrush-----------	Catharus ustulatus
Turkey----------------------	Meleagus gallopauo
Turkey vulture--------------	Cathartes aura
Upland sandpiper------------	Bartramia longicauda

APPENDIX I.--Wildlife species list - Pearl area - Continued

Birds - Continued	
Veery-----------------------	Cahtarus fuscescens
Vesper sparrow--------------	Pooecetes gramineus
Warbling vireo--------------	Vireo gilvus
Western meadowlark----------	Sturnella neglecta
*Western tanager-------------	Piranga lucoviciana
Western wood pewee----------	Centopus sordidulus
*White-breasted nuthatch-----	Sitta carolinensis
**White-crowned sparrow-------	Zonotrichia leucophrys
Yellow-billed cuckoo--------	Coccyzus americanus
Yellow-breasted chat--------	Icteria virens
Yellowthroat----------------	Geothlypis trichas
Yellow-rumped warbler-------	Dendroica coronata
Yellow warbler--------------	Dendroica petechia

Mammals	
Badger----------------------	Taxidea taxus
Black-tailed prairie dog----	Cynomys ludovicianus
Bobcat----------------------	Cynx rufus
Bush-tailed wood rat--------	Neotoma cinerea
Coyote----------------------	Canis latrans
Deer mouse------------------	Peromyscus maniculatus
Desert cottontail-----------	Sylvilagus audubonii
Least chipmunk--------------	Eutamias minimus
Mountain cottontail---------	Sylvilagus nuttallii
Muskrat---------------------	Ondatra zibethicus
Meadow vole-----------------	Microtus pennsylvanius
Mink------------------------	Mustela vison
Mule deer-------------------	Odocoileus hemionus
Northern grasshopper mouse--	Onychomus leucogaster
Northern pocket gopher------	Thomomys talpoides
Ord's kangaroo rat----------	Dipodomys ordii
Porcupine-------------------	Erethrizon dorsatum
Prairie vole----------------	Microtus ochrogaster
Pronghorn-------------------	Antilocarpa americana
Raccoon---------------------	Procyon lotor

APPENDIX I.--Wildlife species list - Pearl area - Continued

Mammals--Continued	
Red squirrel----------------	Tamiaseiurus hudsonicus
Striped skunk---------------	Mephitis mephitis
Thirteen-lined ground squirrel------------------	Spermophilis tridecemlineatys
Western harvest mouse-------	Reithrodontomys megalotis
White-footed deer mouse-----	Peromyscus leucopus
White-tailed deer-----------	Odocoileus virginianus
White-tailed jackrabbit-----	Lepus townsendii
Yellow-bellied marmot-------	Marmota flaviventris

Reptiles	
Bull snake------------------	Pituophis catenifer
Painted turtle--------------	Chrysemys picta
Garter snake----------------	Thamnophis
Prairie rattlesnake---------	Crotalus viridis
Racer-----------------------	Cohiber constrictor
Snapping turtle-------------	Chelydra serpentina
Sagebrush lizard------------	Sceloperous graciosus
Short-horned lizard---------	Phrynosoma douglassi

Amphibians	
Chorus frog-----------------	Pseudacris triseriata maculata
Leopard frog----------------	Rana pipiens
Rocky Mountain toad---------	Bufo woodhousei
Tiger salamander------------	Ambystoma tigrinum

APPENDIX J.--Visual resource management system

The visual resource management rating system evaluates scenic quality, visual sensitivity levels, and visual zones.

1. Scenic quality ratings are based on the presence of landforms, color, water, vegetation, uniqueness, and intrusions. After rating, the areas are grouped into Class A - 15-24 (excellent), Class B - 10-24 (good), or Class C - 1-9 (average). (see Quality evaluation scoresheet)
2. Visual sensativity levels are an index (high, medium, or low) of the relative importance of visual resource. In this case, the only criteria used was number of viewers.
3. Visual zones are areas that can be seen as foreground-middleground (3-5 miles from viewpoint), background (5-15 miles from viewpoint), or seldom seen (areas with little or no visibility, or beyond the the background zones).

Landscape character elements (form, line, color, and texture) are described because they are the basic factors used to measure changes (or impacts) resulting from the proposed action.

FORM: The mass or shape of an object. It is most strongly expressed in the shape of the land surface, usually the result of some type of erosion, but may also be reflected on the shape of the openings, changes in vegetation, or in structures placed on the land.

LINE: Abrupt contrast in form, texture, or color. Lines may be found as ridges, skylines, structures, changes in vegetative types, or individual trees and branches.

COLOR: Usually most prominent in the vegetation but may be expressed in the soil, rock, water, etc., and may vary with the time of day, year, and the weather.

TEXTURE: Result of the size, shape, and placement of parts, their uniformity, and the distance from which they are being obstrued. Texture is usually the result of vegetation or vegetative patterns on the landscape. Texture may also be the result of the erosive patterns in rocks or soil.

These factors are combined to determine visual management classes for which suggested management objectives are prescribed. These classes describe the degree of visual alteration that is acceptable according to Bureau of Land Management standards within the characteristic landscape. Class I provides the greatest amount of protection while Class IV allows for modificatrion of the landscape character.

CLASS I (Preservation): This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

CLASS II (Retention of the landscape character): Changes in any of the basic elements (form, line, color, or texture), caused by an activity, should not be evident in the characteristic landscape.

CLASS III (Partial retention of the landscape character): Changes in the basic elements (form, line, color, or texture), caused by management activity, may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

CLASS IV (Modification of the lanscape character): Changes may subordinate the original composition and character, but must reflect what could be a natural occurrence within the characteristic landscape.

CLASS V (Rehabilitation or enhancement of the landscape): Applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim short-term classificatiom until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

Detecting contrast (or impacts) in the basic elements varies on a scale from 4 (form) to 1 (texture). Assigning values that indicate degree of contrast (3 for strong, 2 for moderate, and 1 for weak) allows a direct multiplier to be set up which will indicate the strength of the contrast. A score of 1-10 for each feature indicates that the contrast can be seen but does not attract attention; 11-20 attracts attention and begins to dominate the landscape; 21-30 demands attention and will not be overlooked. The total score is not as significant as the score for a single feature.

1. Date May 11, 1978	UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT	CLASS	SCORE RANGE
2. Rater Murkin		7	
3. State Montana	QUALITY EVALUATION SCORESHEET	A	15-24
4. District Miles City	6. Recreation Activity	B	10-14
5. Plan Unit Decker-Birney	SCENIC QUALITY	C	1-9

8. KEY FACTORS

9. RATING AREA NO. (a)	NAME (b)	Landform	Color	Water	Vegetation	Uniqueness	Intrusions			11. TOTAL SCORE	12. CLASS	13. REMARKS
	10. POINT MAXIMUM	4	4	4	4	6	2					
	Shell-Pearl	1	2	1	2	1	1			8	C	

(Instructions on reverse)

Form 6110-10 (August 1972)

APPENDIX K.--Maximum theoretical particulate emissions - Shell Oil Company, Pearl mine coal production rate = 2.1×10^6 tons/year

Equipment and materials	Activity	Number of units	Extent of activity/year/unit	Emission factor/year	Source	Maximum 1977 emissions (T/yr)
15 yd^3 power shovel-----	Overburden excavation	2	7,400,000 tons	.042 lbs/ton	1	311
17 yd^3 front end loader-	Coal loading	2	4,000 hours	32.0 lbs/hr.	3	128
Haulage trucks 120 tons-	Hauling overburden	16	23,100 miles	3.52 lbs/mile	5	650
Coal haulage trucks 120 tons--------------	Hauling coal	3	26,000 miles	3.52 lbs/mile	5	137
30 yd^3 scraper---------	Topsoil removal transport	1	2,000 hrs.	32.0 lbs/hr.	3	32
Graders - 200 hp--------	Light spoil grading road maintenance	2	4,000 hrs.	32.0 lbs/hr.	3	128
Tractors - 300 hp-------	Utility use around loading shovels	3	4,000 hrs.	32.0 lbs/hr.	3	192
Blasting----------------	Coal and overburden		520 blasts	77 lbs/hr.	2	20
Tractors - 400 hp-------	Heavy grading at spoil and topsoil dumps	2	4,000 hrs.	32.0 lbs/hr.	3	128
Powder truck------------	Haul blasting agent	2	1,300 hrs.	0.90 lbs/mile	3	1
Sprinkler truck---------	Dust control	1	10,400 miles	0.90 lbs/mile	3	5
Wind erosion------------	Dust transport		56.2 acres	.54 T/acre	1	30
Pickup trucks - 3/4 ton-	Employee transportation	17	20,000 miles	0.90 lbs/mile	3	15
Coal crusher------------	Crushing and screening		2,100,000 tons	2.00 lbs/ton	4	2,100
Coal conveyors----------	Coal transport		2,100,000 tons	2.00 lbs/ton	4	2,100
Blasthole drill 9"------	Drill overburden blastholes	2	16,604 holes	.22 lbs/hole	2	4
Blasthole drill 6"------	Drill coal blastholes	1	16,604 holes	2.24 lbs/hole	2	19
				Total particulate emissions:		6,000

APPENDIX L.--Projected employment and population impacts of the Shell-Pearl mine Big Horn and Sheridan Counties 1978-90

[Source: Coal town II, 1978]

Year	Economic base employment	Ancillary employment	Total employment	County population	Net migration	Hardin population	School children
			BIG HORN COUNTY				
			With the addition of the Pearl mine				
1978--	2,244	2,264	4,508	10,609	134	2,858	2,785
1979--	2,202	2,346	4,548	10,600	-71	2,849	2,783
1980--	2,202	2,445	4,647	10,694	33	2,943	2,808
1981--	2,259	2,573	4,832	10,985	228	3,234	2,884
1982--	2,259	2,679	4,938	11,160	111	3,409	2,930
1983--	2,259	2,783	5,042	11,341	116	3,590	2,977
1984--	2,259	2,889	5,148	11,533	127	3,784	3,028
1985--	2,259	2,996	5,255	11,733	133	3,984	3,080
1986--	2,259	3,104	5,363	11,975	174	4,224	3,144
1987--	2,259	3,213	5,472	12,222	177	4,471	3,209
1988--	2,259	3,323	5,582	12,474	181	4,723	3,275
1989--	2,259	3,434	5,693	12,729	183	4,978	3,342
1990--	2,259	3,546	5,805	13,491	688	5,740	3,352
			Without the addition of the Pearl mine				
1978--	2,244	2,264	4,508	10,609	134	2,858	2,785
1979--	2,202	2,346	4,548	10,600	-71	2,849	2,783
1980--	2,202	2,445	4,647	10,694	33	2,943	2,808
1981--	2,259	2,573	4,832	10,985	228	3,234	2,884
1982--	2,259	2,679	4,938	11,160	111	3,409	2,930
1983--	2,259	2,783	5,042	11,341	116	3,690	2,977
1984--	2,259	2,889	5,148	11,533	127	3,782	3,028
1985--	2,259	2,996	5,255	11,733	133	3,982	3,080
1986--	2,259	3,104	5,363	11,975	174	4,224	3,144
1987--	2,259	3,213	5,472	12,222	177	4,471	3,209
1988--	2,259	3,323	5,582	12,474	181	4,723	3,275
1989--	2,259	3,434	5,693	12,729	183	4,978	3,342
1990--	2 259	3,546	5,805	13,491	688	5,740	3,352

APPENDIX L.--Projected employment and population impacts of the Shell-Pearl mine Big Horn and Sheridan Counties 1978-90--Continued

[Source: Coal town II, 1978]

Year	Economic base employment	Ancillary employment	Total employment	County population	Net migration	Sheridan[1] population	School children
SHERIDAN COUNTY							
With the addition of the Pearl mine							
1978--	3,250	7,374	10,624	22,487	313	15,734	5,904
1979--	3,280	7,625	10,905	22,735	117	15,982	5,969
1980--	3,390	7,912	11,302	23,137	271	16,384	6,074
1981--	3,236	8,104	11,339	23,285	13	16,532	6,113
1982--	3,256	8,364	11,620	23,688	268	16,935	6,219
1983--	3,256	8,638	11,895	24,102	277	17,349	6,328
1984--	3 256	8,923	12,179	24,545	303	17,792	6,444
1985--	3,256	9,219	12,474	25,013	326	18,260	6,567
1986--	3,256	9,526	12,782	25,582	424	18,829	6,716
1987--	3,256	9,848	13,104	26,174	443	19,421	6,872
1988--	3,256	10,183	13,438	26,791	465	20,038	7,034
1989--	3,256	10,530	13,786	27,428	482	20,675	7,201
1990--	3,256	10,890	14,146	29,176	1,589	22,423	7,660

Without the addition of the Pearl mine

Year	Economic base employment	Ancillary employment	Total employment	County population	Migration	Sheridan[1] population	School children
1978--	3,250	7,374	10,624	22,487	313	15,734	5,904
1979--	3,020	7,513	10,533	22,369	-248	15,616	5,873
1980--	3,120	7,776	10,896	22,720	221	15,967	5,965
1981--	3,120	8,028	11,147	23,067	215	16,314	6,056
1982--	3,120	8,287	11,406	23,439	239	16,686	6,154
1983--	3,120	8,556	11,676	23,841	265	17,088	6,259
1984--	3,120	8,836	11,956	24,272	293	17,519	6,372
1985--	3,120	9,128	12,248	24,729	316	17,976	6,492
1986--	3,120	9,431	12,551	25,285	413	18,532	6,638
1987--	3,120	9,750	12,870	25,863	432	19,110	6,790
1988--	3,120	10,080	13,200	26,468	454	19,715	6,949
1989--	3,120	10,423	13,542	27,092	471	20,339	7,113
1990--	3,120	10,778	13,898	28,814	1,564	22,061	7,565

[1]Total urban population includes Ranchester, Dayton, Acme, etc.

APPENDIX M.--Projected impacts of the Shell-Pearl mine on fiscal conditions in Big Horn and Sheridan Counties and the States of Montana and Wyoming, 1978-90

[Source: Coal town II, 1978. Dollar values in constant 1970 dollars]

Year	Net State revenues[1]	Additional State income taxes[2]	Percentage Co. annual growth rates: Rev.	Percentage Co. annual growth rates: Expend.	Percentage school district annual growth rates: Rev.	Percentage school district annual growth rates: Expend.	Hardin revenue per capita
			BIG HORN COUNTY				
			With the addition of the Pearl mine				
1978--	$20,010,680	$715,960	5.6	1.2	-0.7	1.8	$81
1979--	23,809,274	699,568	19.2	-0.1	14.3	-0.1	78
1980--	30,135,991	744,695	-10.6	0.5	17.5	0.9	77
1981--	36,902,108	588,411	18.5	1.8	17.9	2.7	75
1982--	36,981,697	566,079	1.5	1.0	1.3	1.6	73
1983--	40,291,266	566,079	6.9	1.0	6.6	1.6	72
1984--	40,719,425	566,079	0.5	1.1	0.5	1.7	71
1985--	40,615,145	566,079	-0.6	1.1	-0.7	1.7	70
1986--	40,493,903	566,079	-0.6	1.3	-0.6	2.0	68
1987--	40,294,957	566,079	-0.5	1.3	-0.5	2.0	67
1988--	40,230,502	566,079	-0.4	1.3	-0.5	2.0	65
1989--	40,153,265	566,079	-0.4	1.3	-0.5	2.0	64
1990--	40,563,087	566,079	-0.1	3.8	-0.1	5.9	61
			Without the addition of the Pearl mine				
1978--	$20,010,680	$715,960	5.6	1.2	-0.7	1.8	$81
1979--	23,809,274	487,083	19.2	-0.1	14.3	-0.1	78
1980--	30,135,991	536,551	-10.6	0.5	17.5	0.9	77
1981--	35,792,226	536,551	15.3	1.8	14.8	2.7	75
1982--	34,789,689	536,551	-1.2	1.0	-1.3	1.6	73
1983--	38,120,747	536,551	7.3	1.0	7.0	1.6	72
1984--	38,561,048	536,551	0.6	1.1	0.5	1.7	71
1985--	38,467,553	536,551	-0.6	1.1	-0.7	1.7	70
1986--	38,357,503	536,551	-0.6	1.3	-0.6	2.0	68
1987--	38,166,176	536,551	-0.4	1.3	-0.5	2.0	67
1988--	38,109,315	536,551	-0.4	1.3	-0.5	2.0	65
1989--	38,039,954	536,551	-0.4	1.3	-0.5	2.0	64
1990--	38,457,096	536,551	-0.1	3.8	-0.1	5.9	61

[1] Does not include State income taxes paid by miners who work in Montana but live in Wyoming.

[2] State income taxes paid by miners who work in Montana but live in Wyoming.

APPENDIX M.--Projected impacts of the Shell-Pearl mine on fiscal conditions in Big Horn and Sheridan Counties and the States of Montana and Wyoming, 1978-90--Continued

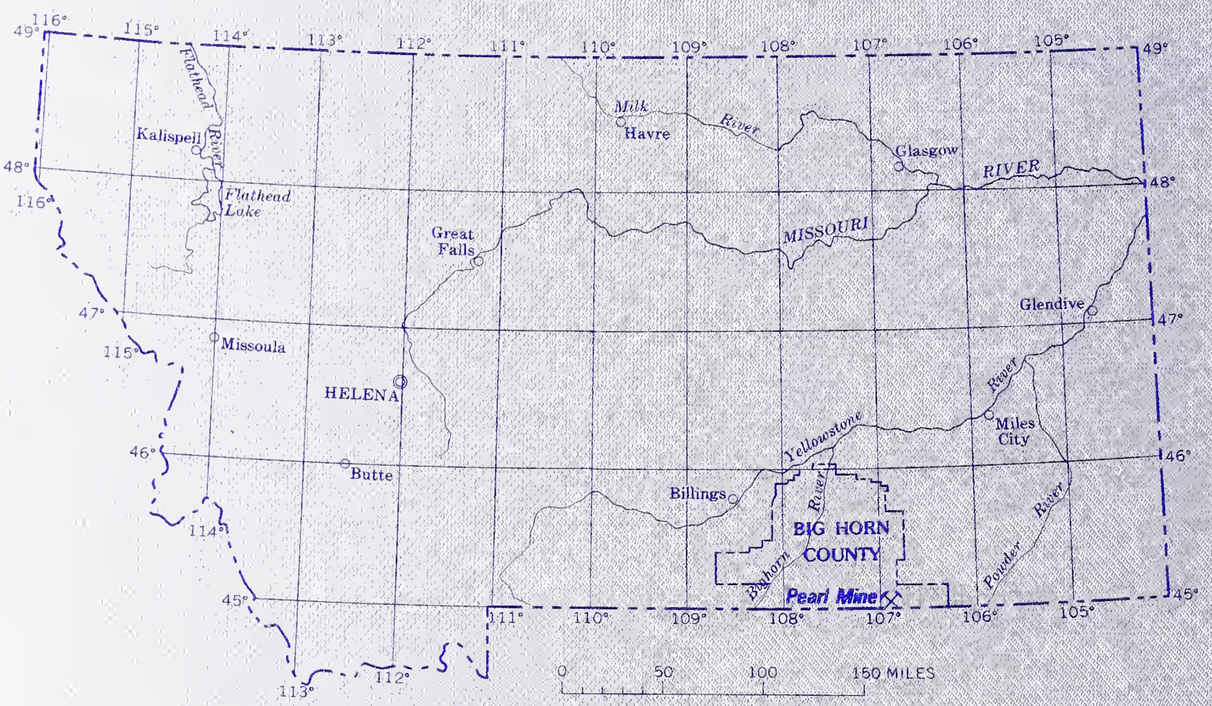
[Source: Coal town II, 1978. Dollar values in constant 1970 dollars]

Year	Net State revenues[1]	Additional State and local sales taxes[2]	Percentage Co. annual growth rates Rev.	Percentage Co. annual growth rates Expend.	Percentage school district annual growth rates Rev.	Percentage school district annual growth rates Expend.	Sheridan revenue per capita
			SHERIDAN COUNTY				
			With the addition of the Pearl mine				
1978--	$1,919,905	*	-4.6	1.9	1.8	2.0	$83
1979--	2,844,806	*	11.0	1.0	3.3	1.1	86
1980--	2,835,277	*	1.1	1.7	1.7	1.8	86
1981--	2,750,962	*	-1.0	0.6	0.7	0.6	83
1982--	2,877,199	*	2.7	1.6	1.7	1.7	86
1983--	2,900,497	*	1.0	1.6	1.7	1.7	85
1984--	2,943,828	*	1.4	1.7	1.8	1.8	85
1985--	2,986,141	*	1.4	1.8	1.9	1.9	85
1986--	3,033,168	*	1.7	2.1	2.2	2.3	86
1987--	3,067,345	*	1.5	2.2	2.3	2.3	85
1988--	3,108,995	*	1.6	2.2	2.3	2.3	85
1989--	3,151,771	*	1.7	2.2	2.3	2.4	85
1990--	4,191,370	*	12.4	6.0	8.1	6.3	86
			Without the addition of the Pearl mine				
1978--	$1,919,905	*	-4.6	1.9	1.8	2.0	$83
1979--	2,756,278	*	9.1	-0.5	1.8	-0.5	85
1980--	2,757,387	*	1.3	1.5	1.5	1.6	85
1981--	2,769,514	*	0.7	1.4	1.5	1.5	85
1982--	2,812,722	*	1.3	1.5	1.6	1.6	85
1983--	2,853,849	*	1.3	1.6	1.7	1.7	85
1984--	2,895,521	*	1.3	1.7	1.8	1.8	85
1985--	2,937,586	*	1.4	1.8	1.8	1.9	85
1986--	2,984,535	*	1.7	2.1	2.2	2.2	85
1987--	3,018,552	*	1.5	2.1	2.2	2.3	85
1988--	3,060,022	*	1.6	2.2	2.3	2.3	85
1989--	3,102,572	*	1.7	2.2	2.3	2.3	85
1990--	4,142,801	*	12.5	5.9	8.1	6.3	86

[1]Does not include sales taxes collected from Montana residents who shop in Sheridan.

[2]Sales taxes collected from Montana residents who shop in Sheridan.

*Not available.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Flathead River
Flathead Lake
Milk River
Havre
Glasgow
MISSOURI RIVER
Great Falls
Glendive
Missoula
HELENA
Butte
Billings
Yellowstone River
Miles City
BIG HORN COUNTY
Bighorn River
Powder River
Pearl Mine
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